DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND

REPORT

ON THE

SEA AND INLAND FISHERIES OF IRELAND

FOR

1901.

IN TWO PARTS.

PART I.—GENERAL REPORT.

PART II.—SCIENTIFIC INVESTIGATIONS.

PART II.—SCIENTIFIC INVESTIGATIONS.

Presented to both Houses of Parliament by Command of His Majesty.

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(62 AND 63 VIC., CAP. 50.)

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1903.

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To

His Excellency WILLIAM HUMBLE, EARL OF DUDLEY, Lord-Lieutenant-General and General Governor of Ireland.

MAY IT PLEASE YOUR EXCELLENCY,

I am directed by the Vice-President to submit to Your Excellency the Report on the Sea and Inland Fisheries of Ireland for the year 1901, Part II., Scientific Investigations.

I have the honour to remain,
Your Excellency's faithful Servant,
T. P. GILL,
Secretary.

DEPARTMENT OF AGRIOULTURE AND
TECHNICAL INSTRUOTION FOR IRELAND,
UPPER MERRION-STREET,
DUBLIN, 27*th April*, 1903.

DUBLIN CASTLE,
28*th April*, 1903.

SIR,

I have to acknowledge the receipt of your letter of the 27th instant, forwarding, for submission to His Excellency the Lord Lieutenant, the Report on the Sea and Inland Fisheries of Ireland for 1901, Part II., Scientific Investigations.

I am,
Sir,
Your obedient Servant,
J. B. DOUGHERTY.

The Secretary,
Department of Agriculture
and Technical Instruction,
Upper Merrion-street.

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TO THE

SECRETARY OF THE DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND.

Department of Agriculture and Technical Instruction for Ireland,
Fisheries Branch.

SIR,

I have the honour to submit the following Report, prepared by Mr. E. W. L. Holt, Scientific Adviser to the Fisheries Branch of the Department, and forming Part II. of the Report on the Sea and Inland Fisheries of Ireland for 1901, *submitted in August of last year.*

I have the honour to be,
Sir,
Your obedient servant,

WM. SPOTSWOOD GREEN,
Chief Inspector of Fisheries.

22*nd April,* 1903.

SEA AND INLAND FISHERIES, 1901.

REPORT OF THE SCIENTIFIC ADVISER.

To the Chief Inspector of Fisheries.

Sir,

In accordance with your instructions I have the honour to submit my report of the scientific work of the Fisheries Branch of the Department for the year 1901.

As this is the first occasion on which such a Report has been presented in separate form I propose to advert briefly to its scope.

The work of scientific investigation entrusted to my charge has been, and will be in the future, in the first place directed to objects of obvious and immediate economic importance; but in the pursuit of such objects it is inevitable that we should encounter information which may appear to be of purely scientific interest. It requires, I believe, no argument on my part to demonstrate that our inability to perceive the importance of such bye-products, as I may term them, of our main investigations, is solely due to the limitations of our present knowledge; since it is not conceivable that any factor in the environment of an organism of economic importance can be without influence, direct or indirect, on the well-being of the organism. It is well known that in other branches of natural science researches of what once appeared a purely philosophic nature have, in the light of wider knowledge, been found to possess an eminently practical bearing.

I therefore propose to include in the Report of Scientific Investigations all matter of which, in the course of our researches, we may acquire information which seems worthy of publication, whether of obvious economic importance or not. In pursuing this course I shall err, if at all, in the company of my colleagues of all countries in which scientific investigations are carried out by the fishery authority.

The preparation of this Report has been delayed by the great call made upon the time of the scientific members of the staff by the organisation and administration of the Fisheries Section of the Cork International Exhibition. The same cause has resulted in the postponement until next year of papers dealing with the Mackerel and Oyster Fisheries. I am glad, however, to be able to report that our efforts in connection with the Exhibition met with so much intelligent recognition in the country that the educational result may be taken to have more than compensated for the interruption in our ordinary work. A brief note of the scope of the Fisheries Section of the Exhibition will be found below.

With regard to the scientific investigations I have to report as follows:—

SEA FISHERIES.

Trawling.—A survey at regular intervals of the trawling grounds in the Irish Sea has been commenced, and will be continued in future years. In addition to the record of fish and other animals captured, arrangements have been made for the analysis of the bottom deposits with a view to correlating the fauna with the composition of the sea floor. I do not propose to put forward the result of the work until it has been carried on for a considerable period, when it will be possible to compare the results of successive years. I may note, however, that I provisionally estimate the size at which the plaice attains sexual maturity in this region at 12½ inches. The maturity limit of this fish is of the greatest importance in considering the effect of trawling and other fisheries on certain grounds on the future stock.

Porcupine Bank.—In the Appendix (p. 3) is given a brief account of our exploration of this ground. It appears, as we long suspected, to be at least fairly stocked with halibut; but at present there are, in this country, no vessels suitable for the prosecution of a line-fishery at so great a distance from port. Its capabilities for trawling we were not able to ascertain. Inquiry as to the result of our fishing has been made by the captain of a steam-liner, who was a member of our crew during the survey of western grounds in 1891. He has since fished on the bank; but with what result I have not yet heard. The valuable observations of Professor Cole (Appendix, p. 133) on the bottom deposits from this and other deep-sea grounds on the west coast, which we visited in the course of the year, constitute, as I hope, the nucleus of a complete survey of the composition of the Irish Atlantic slope, as opportunity may permit us to obtain the necessary material. In the present day of economic deep-sea fishing, owing to the apparent depletion of shallow areas, nothing which can increase our knowledge of the capabilities of the western area is without importance.

Oyster Fisheries.—The oyster industry, once of great importance in this country, is at present in a very depressed condition. This is, in part, due to the low state of the market, which renders it difficult to dispose of the coarser grades of natural oysters at a price remunerative to dredgers; and partly to the shortage of local supplies of seed oysters suitable for relaying on fattening beds.

In the Appendix (pp. 4 to 36) will be found an account of a survey made of the natural oyster grounds on the coasts of Counties Wicklow and Wexford. In former years, when the demand was great, these grounds were extensively worked by the local fishermen, the head-quarters of the industry being at Arklow. Excessive dredging resulted in the practical depletion of the

beds, which have now, however, recovered, in places, to a considerable extent. It will be seen from the report of the survey that the most prolific area lies at a considerable distance from any port, and, owing to the exposed nature of the coast, the expenses of working the grounds require a price greater than seems at present obtainable for this class of oyster.

The relaying industry is carried on chiefly on the west and south-west coasts of the country, and formerly derived the resources necessary to its prosecution from a number of natural beds producing oysters of a suitable quality. Some of these beds have been dredged out, and the remainder appear to be in danger of a similar fate, in spite of precautions which have been taken, by way of by-law, to minimise the risk.

Since there appears to be a ready market for high-grade oysters, the regeneration of the industry would seem to be feasible, if it were possible to adapt to local conditions the Continental methods of securing the highest possible percentage of the spat set free during the breeding season, and thus increasing the supply of native seed oysters. Experiments with this intent have been instituted by the Department, and the results will be reported in due course.

Apart from native seed, questions of great importance to Irish relayers are the relative value, for local purposes, of stock imported from different centres of distribution in other countries, and the method of treating stock on relaying beds.

Information upon these points is frequently demanded from the Department; and no means of supplying it have hitherto been available. Experiments have accordingly been instituted, the seed oysters under observation being derived from Tralee and Clarenbridge, in Ireland; the Isle of Wight and Kentish Knock in England, and Auray and Arcachon in France. A few Dutch oysters are also being tried, as well as the South European species known as "Portuguese." The experiments are not yet in a sufficiently forward state to be dealt with in this Report; but a considerable amount of information has been acquired, and is at the disposal of inquirers.

By the courtesy of the author, Herr Wollebaek, I am able to publish in the Appendix (pp. 77 to 103) translations of some papers on the Norwegian system of oyster-culture, which, I believe, will be read with great interest by western cultivators.

Mackerel Fishery.—I had hoped to have been able to include in this Report some account of our researches in regard to the mackerel fishery since their commencement in 1899, but circumstances mentioned above have rendered this impossible. I may note, however, in regard to the unproductive spring fishery of 1902, that the scarcity of fish is shown by Mr. Farran's records (Appendix, p. 105) to have been accompanied by a corresponding scarcity of Copepoda, the organisms which form the principal food of the mackerel at this season.

Our experiments in attempting to strike the mackerel by means of nets sunk to different depths, as well as at the surface, before the commencement of the ordinary season, do not, up to the present season, give any promise of the possibility of establishing such an early fishery on a sound commercial basis. As you are aware, I have consulted with Mr. Lane and yourself as to the advisability of extending these experiments by chartering steam drifters to work off the south-west coast at considerable distances from land, a proceeding which is not possible for the sailing vessel with which our mackerel work is at present carried on. We decided that the indications of possible success were not sufficient to justify the large expenditure involved; while the limitation of fishing imposed by the weather, which may be expected at this season of the year, increased, as it must necessarily be, by the time occupied in proceeding from the distant fishing ground to the port of market and back, would probably neutralise any advantage obtainable by the high price which the mackerel would command if the fishery proved successful.

Ichthyological Notes.—In the Appendix (pp. 37 to 66) will be found a paper on the British and Irish species of the genus Gobius, small fishes of world-wide distribution, of some importance as the food of adult marketable species or as competitors and, possibly, enemies of their younger phases. The work, which Mr. Byrne and I commenced some years ago, for our own information, will, I believe, be found useful by all who have occasion to study the environment of our food-fishes.

The developmental history of the white sole is the subject of a short paper, and another deals with the occurrence upon our shores of the rudder-fish, a straggler from the American side of the Atlantic; and as the few fishes of this family which occasionally visit us are very imperfectly known from accessible literature, and are commonly confused with quite different forms, we have taken the opportunity of defining them in a manner which, we trust, will prove of easy interpretation.

Copepoda.—Mr. Farran's paper on the Copepoda of 1901 must be taken as a section of the results of the mackerel investigations.

Nudibranchiata.—Another paper by Mr. Farran, on the Nudibranch molluscs, is the first of a series of memoirs descriptive of the fauna of the waters adjacent to the stations of the marine laboratory.

INLAND FISHERIES.

Statistics of Salmon Fisheries.—In the Appendix (pp. 142 to 145) are given such statistics for the year 1901 as I am at liberty to publish. Few as they are, they sufficiently indicate the disastrous nature of the season. While withholding any further remark upon the fishery, I may note that the run of peal was everywhere exceptionally small, while the descent of fry was, in so far as I can rely on the information received, exceptionally

large. The conditions of rivers for the winter of 1901-1902 appear, from reports received from the Clerks of Boards of Conservators, to have been unusually favourable to spawning, and to the protection of spawning fish, the number of which shows, on the whole, a decided increase, in so far as it is possible to form an opinion on the matter.

Artificial Propagation.—I have reported at some length on this subject, in the Appendix (pp. 148 to 164). The number of fry turned down shows an advance on previous years, and I believe that the method of distribution shows an improvement.

Salmon Marking.—My report in the Appendix (pp. 165 to 196) deals fully with the result of our work in this direction up to date. I would call special attention to the Lismore experiments, the results of which seem to indicate that, in the Blackwater, if not elsewhere, the clean fish which run in the late autumn and winter are only temporary sojourners in fresh water.

Pollen.—In continuation of the work of last year (see Report for 1900, Appendix, p. 16), I have examined a number of pollen, with a view to ascertaining the size at which maturity is reached. The result gives no indication that the legal size limit of eight inches is unduly high (Appendix, pp. 146-147).

Reports of Clerks of Conservators.—The summary of reports from Clerks of Conservators is, for the present year, included in the Appendix to this Report (pp. 205 to 213). In future years it will be divided into an economic and a scientific section, which will appear, respectively, in Parts I. and II. of the Annual Report.

CORK EXHIBITION.

In the organisation of the Fisheries Section the objects which we sought to attain were (i.) the development of the sea and inland fisheries by the exhibition of methods by which an improvement on existing conditions seemed possible, and (ii.) a demonstration of the material fishery resources. I need here advert only to a few of the exhibits which were in special relation to the ordinary work of the scientific staff.

Artificial Propagation.—Inquiries constantly reach us as to the best methods and apparatus for adoption and use in salmon and trout hatcheries, and we sought to give information on these points by exhibiting specimens of hatching gear from some of the leading hatcheries in the United Kingdom, Germany, and America. The apparatus designed and used by Herr Jaffé, of Sandfort, Osnabrück, are remarkable for simplicity of construction and efficiency, and I have accordingly asked Mr. Charles Green to prepare specifications and working drawings of Herr Jaffé's exhibits. These will be found in the Appendix (pp. 197 to 204), and will also be printed separately for distribution to inquirers.

Trout Farming.—The exhibit included a series of ponds and water-courses stocked with fish of different ages, and with the

proper water-plants, with a view to illustrating a system of trout-farming for the market which appears to give promise of profitable adoption in this country. In so far as was possible in the grounds of an Exhibition the ordinary routine of the business was carried out under the eyes of visitors.

The principal enemies of the fry of trout and salmon, and the developmental stages of some of the insects which form the food of adult trout were illustrated by means of mounted preparations.

Oyster Culture.—Continental methods of cultivation were very fully illustrated by specimens of the apparatus in use at Arcachon and Auray, and in Norway, and the thanks of the Department are due to the Societé Immobilière du Moulleau et des Pêcheries de l'Océan of Arcachon, and to M. Jardin, of Auray, for their generous gifts of apparatus and models.

At the close of the exhibition season of 1902, the apparatus was removed to the offices of the Department, where they can be inspected on application. A fairly complete series of Irish oysters, natural and relaid, was exhibited.

Young Stages and Food of Sea Fish.—The life-history of sea fishes, from the egg to the end of the larval condition, was illustrated by means of transparency cases, in which the actual organism was shown side by side with a large scale drawing. An extensive series of the small animals which form the food of some of the most important food-fishes was illustrated in same manner.

It is a pleasant duty to acknowledge the assistance I have received in the preparation of this Report, and in the work of scientific investigation generally, from my colleagues, Mr. C. Green and Mr. G. P. Farran, the Assistant Naturalists; and from Mr. A. B. E. Hillas, the Technical Assistant of the Fisheries Branch.

I cannot close the Report without adverting briefly to the great loss we have sustained by the death of Mr. M. F. Woodward, of the Royal College of Science, London, who was drowned by the capsizing of a boat in Ballynakill Harbour, on the night of the 15th September. For three years Mr. Woodward had assisted us, during his summer vacation, in the work of the Marine Laboratory. In him Biological Science loses one of its ablest workers, while I must mourn him as one of my oldest and dearest friends. The work which he left on the mollusca of the west coast is being completed by one of his colleagues in the Malacological Society, and will be published in the next issue of this Report.

I have the honour to be, Sir,

Your obedient servant,

E. W. L. HOLT,

Scientific Adviser.

APPENDIX

TO THE

REPORT

ON THE

SEA AND INLAND FISHERIES OF IRELAND

FOR

1901.

PART II.—SCIENTIFIC INVESTIGATIONS.

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APPENDIX, No. I.

THE PORCUPINE BANK.

Taking advantage of a spell of unusually calm weather, the "Helga" left Ballynakill, County Galway, for the Porcupine Bank at 8.30 p.m., on June 28th.

Early next morning soundings were made in a position about 112 miles from High Island, and a depth of 115 fathoms was found, the nature of the bottom being coarse sand, shells and stones. Having again sounded further to the west in 97 fathoms the course was continued until 10.30 a.m., when 700 fathoms of long-lines were shot in a depth of 91 fathoms, the bottom being of a similar character to that found at the previous soundings.

The lines consisted of two of 300 fathoms each, and a third of 95 fathoms. One had 150 cod and conger hooks, one 150 medium hooks, and the third (the short one) 95 haddock hooks with hair snoods. The bait used was sections of spring mackerel on the large hooks, and half-sections on the small.

The lines were left down about 3¼ hours, during which time there appeared to be no appreciable current on the buoys, and were hauled in the ship's lifeboat with some difficulty, owing to the stony nature of the bottom. The take consisted of eight halibut, from 20 to 48 lbs. weight, 12 ling, from 44 inches to 52 inches long, one coal fish of 37 inches, one grey skate, two thornback, nine rough dogfish, and one blue shark, 8 feet long.

During the time the lines were on the bottom, the dredge was used, bringing up quantities of dark granite-like stones, and various invertebrates. Townets were used at the surface, mid-water and bottom. At 5.30 p.m. the ship started homewards, stopping to sound and dredge in 120 fathoms, and to sound in 175 fathoms, Ballynakill being reached at 10 a.m. next morning.

It may be noted that none of the ground on which soundings were taken appeared suitable for trawling.

Owing in part to a dense fog which prevailed most of the time, it was difficult to fix positions with accuracy, but the lines were shot approximately in lat. 53° 26′ W., long. 13° 30′ N.

Various indications pointed to the probability that the ground close to the westward was more "fishy" than where the lines were actually shot.

The several results were, of course, far from conclusive, owing to the small area of ground that was tested, but it is important to know that there are marketable fish to be caught on this bank under conditions similar to those which obtain on the Rockall Bank, where sailing line boats from the east coast of England carry on a profitable industry.

Since the expedition, it has been reported that steam-trawlers have trawled on part of the Bank with some success.

The scientific results of the expedition will be dealt with on a future occasion.

APPENDIX, No. II.

THE PUBLIC OYSTER BEDS ON THE COASTS OF COUNTIES WICKLOW AND WEXFORD.

BY

E. W. L. HOLT.

i.—INTRODUCTORY.

The investigation with which I am about to deal arose out of applications made to the Department on behalf of the fishermen of Arklow and Courtown to take steps with a view to the revival of the once important oyster fishery of the neighbouring coast.

I am not here concerned to discuss in detail the various methods by which it was suggested that the desired end might be achieved; but, in brief, it was proposed from Arklow that the Department should bear the charges of a scheme for placing the oysters on the English market at a price remunerative to the fishermen.

Whatever the merits of such an enterprise, or the possibility of its modification to a degree compatible with the restrictions imposed by statute on the Department's powers in the expenditure of public money, it was obviously necessary to ascertain to what extent the available supply of oysters would seem to warrant the inception of an extensive fishery, accompanied, as it needs must be, by the expenditure on the part of owners of fishing boats of a considerable capital in the purchase of gear and fittings.

Reports on this subject were most conflicting. In former days dredging was pursued on grounds extending, practically without interruption, from Wicklow Head to Carnsore Point, chiefly inside the line of sandbanks which fringe the coast in this region. It was matter of common knowledge that these beds had been so seriously over-fished that the industry became but little profitable on that account alone; though a slackness of demand for oysters and the diversion of the energies of Arklow to the spring mackerel fishery, were no doubt causes in part contributory to its practical abandonment.

The recent uncertainty of the mackerel and herring fisheries recalled attention to the oysters, and it was asserted by some that the beds, after lying fallow so long, had completely recovered and were as well stocked as ever. Further, it was held that there was evidence of the existence on off-shore grounds of productive beds which had never been worked at all.

Other information suggested that the grounds near the fishing ports were very poorly stocked, while as the more remote inshore beds did not appear to have been worked for many years, it was evident that nothing very exact could be known about them.

I was accordingly directed to make a survey of the whole of the known grounds, and to search for the supposed off-shore beds. Work was commenced in the early spring of 1901, and has been continued, as the weather, and other duties of the "Helga" per-

mitted, ever since. Interruption from both these causes has been frequent, and the survey has not yet been completed in such detail as I originally contemplated; but for our present purpose the information already acquired will probably suffice, and a more detailed report may be left to form part of the systematic examination of all our eastern fishing grounds, which is an item in the work of the Scientific Section of the Fisheries Branch.

With a view to locating the grounds known to have been productive in former years, we secured the services of James Craan, of Arklow, who was engaged in the industry in the days of its greatest success. He acted as our pilot and fishing master from Wicklow Head to Glasgorman; while Michael Wafer, of Courtown, performed a similar function from Pass to Ballyvaldon. Matt. O'Brien, of Arklow, fishing master at the Marine Laboratory, was employed when some of the ground was re-examined. In our search for the off-shore grounds we were guided by a chart marked at Arklow.

We did not restrict our dredging, either inshore or off-shore, to the localities indicated, but generally quartered the whole coast as closely as the time at our disposal permitted. Thus, although isolated patches may have escaped us, it is unlikely that we missed any oyster-bearing ground of sufficient extent to be of much importance in a large fishery.

Dredges of approved pattern were supplied to us from Arklow and Courtown, and in their manipulation we were guided by the instructions of the experts whom I have named. The "Helga," a vessel of 345 tons, is rather large for the work, but by choosing suitable states of tide and taking advantage of her twin screws when required, we found her handy enough.

I have thought it permissible to assume that a professional sailing dredger working over the same grounds would have caught rather more than we did, dredge for dredge, while she would usually work a larger number of dredges: though, as will appear, the superiority of the sailing dredger is perhaps not constant (see p. 34). It is possible, therefore, that my conclusions as to the stock may be unduly optimistic, but as the numbers taken are stated, readers are in a position to form their own opinion.

The catches of individual hauls are set forth below, but I may at once summarise our results by stating that, in so far as I can form a judgment, the great Ballyvaldon bed inside the Blackwater sandbank is the only ground which seems at present capable of meeting the requirements of a considerable fleet of powerful vessels. It is a ground of large extent, but that it is capable of long withstanding an important fishery, I should hesitate to affirm. There are, at many other places which we examined, isolated patches of productive ground, capable of supporting a reasonable fishery if the oysters were of sufficient market value to compensate for the periods of enforced idleness inevitable on a coast at once so exposed and so devoid of good harbours.

Of the alleged off-shore grounds, I can only say that we found no evidence of their existence, though here and there we met with an occasional oyster.

Before proceeding to a statement of our hauls, it may be of interest to review briefly the past history of the industry, so far as it can be gathered from the reports of the Fisheries Office, and other sources.

ii.—HISTORICAL AND ECONOMIC NOTES.

I have not been able to learn at what period the fishery commenced to assume importance, and have no knowledge of the number and class of the boats by which it was prosecuted in the first half of the nineteenth century. In or about the year 1806 there were complaints of exhaustion of the stock, which may probably have referred only to the beds in the immediate neighbourhood of the ports. It is evident that there was a considerable industry, even in the late thirties, of which Arklow was the headquarters. Courtown boats probably landed their catch at Arklow, as in recent years, and Wexford men seem also to have been occupied in dredging to a considerable extent. At this period the Arklow men at least were in the habit of conveying some considerable proportion of their catch to Beaumaris, where the oysters were relaid to fatten for the English market. That others were relaid at Clontarf and Sutton is probable, but I find no mention of the fact until some years later. The price appears to have been so low that it is only by taking into account the change in the value of labour that it is possible to regard the industry in these early years as remunerative. Herring fishing seems to have been the staple industry.

In the early forties a great stimulus was given to the trade by the arrival at Arklow of English buyers, who carried off stock to replenish the Kent and Essex beds, and are stated to have made purchases at Arklow to the value of £8,000 in the spring of 1843. It must be remembered that at this period the French and Dutch beds, which now play an important part in the restocking of English and even Irish beds, and in the direct supply of the English market, were in bad condition. The deep-sea Dutch grounds were, I believe, unknown, and there was no importation from America.

The legal close season was from the 31st April to 31st August, but in 1846 dredging, for stocking purposes only, was permitted during the month of May. In the same year it is noted that the system of relaying at Beaumaris, abandoned when the English buyers appeared at Arklow, was at least in part resumed, as being more profitable than sale at Arklow. The enforcement in 1856 of the provisions of the French Convention Act, which applied to Beaumaris though not to Ireland, appears, by closing the month of May, to have dealt a serious blow to this trade.* At what period the Irish close season became really effective is not clear, but it seems to have been observed in the forties, while in previous years the fishery was regulated by an unofficial close time of September to January, during which the "home beds" were left unmolested.

The year 1856 may be taken to approximately mark the inception of the experiments in oyster culture which have resulted in the complete rehabilitation of the French and Dutch oyster trades. In 1859 it is reported that "nearly all the public natural beds" in Ireland had "been worked out by over-dredging and improvident neglect in not restoring the unsizeable oysters to the banks": but this statement was of a general application, and not apparently intended to refer specially to the east coast grounds, which certainly remained productive for some years longer; though we shall find in the returns ample

*Mention is made, however, of buyers of Arklow Oysters at Beaumaris as late as 1880.

evidence that the output was much in excess of their recuperative power. That these beds were already suffering seems to be indicated by an application from the local fishermen "to prevent the improvident dredging of oysters by limiting the number of boats." Such an administrative measure, however beneficial its probable effect to the public not less than to the individuals whom it might favour, being in the nature of an infringement of public rights, has never been within the powers of the Fishery Authority nor, perhaps, of Parliament.

In 1862 is reported a general scarcity of large deep-water oysters, for which there appears to have been a good demand. Indeed, even in high-grade oysters, a large size and coarse shell seems to have been no disadvantage, so long as the fish was good. For several years it is probable that French buyers had been operating at Arklow, in part, at least, on behalf of the Imperial Government, which was then expending considerable sums on restocking the public beds, and in providing breeding stock for the cultural experiments, from which has resulted the present seed-industry of Auray and Arcachon. Dutch buyers receive little mention in the reports, but are well remembered by old fishermen of Arklow, and seem to have taken a lot of oysters away for restocking purposes. Boats from England and Jersey seem to have been taking a share in the fishery for some years.

In 1863 we are for the first time able to deal with actual figures of the catch, or rather of the number of barrels sold at Arklow. The returns—furnished by Mr. P. Maher, harbour master at Arklow from 1863 to 1869—are not complete, as in some cases only the catch of the spring fishing is given.

The total for 1863 is 58,165 barrels, value £12,281, average price 4*s.* 3*d.* Of these 44,500 barrels, value £9,695, were taken by the spring fishing, 1st January to 31st May. There were despatched to the Irish coast, chiefly Dublin, 7,988 barrels; to the Welsh coast (Beaumaris?), 2,860 barrels; to France, 2,600 barrels; and to London and Kent, 20,590 barrels.

It is probable that a considerable number of the oysters taken on the eastern beds do not figure at all in these returns, since I believe the Jersey men did not land all their catch; while, as will appear below, their boats fished harder than those of the local ports. Their boats also appear, from the present recollection of Arklow, to have been larger and more efficiently equipped for dredging, and able for fishing grounds not usually accessible to the Arklow fleet. The barrel seems to have been of the same size as that now used for herring, and has been stated to me to have contained from four to six hundreds* of oysters at the period with which we are dealing. If these statements are approximately correct it is evident that the Commissioners' note in the previous year of the scarcity of large deep-water oysters was amply justified, since at present unsorted oysters from any of the Eastern grounds, cleaned and tightly packed, would not average three hundreds to the barrel. To some extent this difference would be one of shell rather than of fish, as constant dredging with the chain-ring net in use at Arklow must have the effect of checking the exuberance of shell-growth, tending

* Three to five hundreds of 126 in 1880, according to evidence given at an inquiry held that year. Four and a half hundreds is mentioned in a report from the Coast Guard in the seventies.

to produce a small deep oyster rather than the big shallow form which is now the most common on the beds. It is probable that this furnishes the interpretation of a statement made at Arklow, to the effect that when a bed is first dredged "old men," *i.e.*, very large oysters (of little market value) are first taken, and that when these have been skimmed off a smaller and better quality is found underneath them. But the history of this and other fisheries seems to show that although heavy dredging may for a time improve the quality of the oysters, it almost infallibly results in their practical extermination. There is, I think, now no means of knowing how the return for this year compares with the unrecorded catches of previous seasons, nor of forming an opinion of the extent to which the output may have been affected in different years by variation in the number of boats and dredges at work. Every succeeding season shows a decline in the catch, and since the price largely increased, it is reasonable to suppose that there was at first no great reduction in the fishing power employed. It is probable that the take of 1863 was considerably exceeded by that of previous years, as indeed was indicated by the evidence laid before the Commissioners in the succeeding year.

The total for 1864 is returned at 52,818 barrels, value £16,790, average price 6*s.* 4*d.* Of this the spring fishery contributed 34,038 barrels, value £10,829, 600 to 700 (about 5 to 6 Arklow hundreds) to the barrel.

In this year the Commissioners held an inquiry on the petition of the fishermen of Arklow, Gorey, Courtown, and Wexford. It was sought to withdraw the permission to dredge for stocking purposes during the month of May. Special protection was desired for the Arklow, Pass, Roney, Ballyvaldon, Blackwater, and Wexford beds, which are described as being at less than a mile from the shore, varying in breadth from half a mile to four miles, and extending in almost unbroken series from Wicklow Head to near the Tuskar. It seems to have been abundantly proved that the beds were seriously depleted, and it was mentioned that the "Barrack" bed (the position of which I have not been able to ascertain), though discovered only a year previously, was already dredged out. Arklow men wished the close season to be from the middle of May to the end of October, as they could occupy themselves with the herring during the autumn months; but Courtown men, who were not equipped for following the herring, wished to close the whole of May and leave the autumn months open. English buyers objected to any alteration on the ground that if the beds were not constantly dredged the quality of the oysters would deteriorate. There appears to have been considerable feeling against the Jersey men, who were alleged to fish day and night, week days and Sunday.

The Commissioners fixed the close season for all grounds between Lambay to Carnsore from 30th April to 1st October. There appears, from their report, to have been at this time a practically unlimited demand for Arklow oysters on the part of English and French buyers.

In 1865 the total fell to 23,065 barrels, value £14,936, average price about 13*s.* The spring season, 1st January to 30th April, yielded 15,851 barrels, value £11,319, average price 14*s.* 3*d.* These were despatched—to the Dublin beds, 2,274; to London

and Kent, 11,407; to France, 2,130 barrels. The autumn season, 2nd October to 4th November, gave 7,214 barrels, which were despatched—to Dublin, 2,050; to Clontarf, 500; to Falmouth, 1,994; to London and Kent, 2,670 barrels.

The decline in the catch is of course in part due to the curtailment of the open season, which at first caused some dissatisfaction; complaints, however, were dissipated by the advance in price, which averaged quite double that of the previous year. The Commissioners note a complaint received from Carlingford of the practice of relaying in the Lough oysters from the alleged poisonous water of Arklow and selling them as genuine Carlingford natives. About this period the reports contain frequent allusion to the discovery of new beds, but without detail of locality. It seems probable that these refer rather to extensions of the known productive areas of the main beds than to entirely new tracts of ground; and, taking into consideration the strength of the tide on this part of the coast and the certainty of its occasional modification in direction by wind action, it may be suspected that spat may from time to time be carried to and stock a new area, which would remain productive only for the life-time of that particular stock, its offspring not being allowed by the tide to settle on the same spot.

Allusion is also made in several reports to the supposed existence of oyster-bearing tracts in deep water, beyond the reach of the Arklow fleet of that period.

In 1866 the total was 15,790 barrels, value £8,693, average price 11*s*.

During this year dredging appears to have been more than usually interrupted by the weather, and although reference is made to an improvement in the harbour, it is evident that it remained in a most unsatisfactory condition for some years longer. Arklow boats found employment in May in working for the Wicklow copper mines. The number of boats engaged in dredging is stated to have greatly increased, but no comparative figures are forthcoming.

In 1867 the total was 25,924 barrels, value £13,001, average price 10*s*. Of this the autumn fishing, from 1st to 24th October, and from 10th to 21st December, yielded 9,160 barrels, value £4,050, average price 10*s*. 6*d*.

The number of boats dredging is stated to have been 200, and the bulk of their catch came from two new beds off Arklow, the name of which is not mentioned. The Commissioners permitted dredging for stocking purposes during the first half of May, but commenced to take steps to extend the operation of the close season beyond the exclusive limits of Ireland.

In 1868 the total was 30,628 barrels, value £19,440, average price about 12*s*. 9*d*.

The spring season, from 27th January to 15th May, yielded 21,644 barrels, value £13,601, average price 12*s*. 6¾*d*. Of these were despatched—to Dublin, Sutton, and Clontarf, 12,334; Carlingford, 250; Beaumaris, 240; London and Kent, 8,110; and to Holland, 710 barrels.

The autumn season, from 1st September to 17th October, gave 8,984 barrels, value £5,839, average price 13*s*. Of these were despatched—to Dublin and Dublin Bay, 4,884; and to London and Kent, 4,100 barrels.

The Commissioners withdrew the permission to dredge during the first half of May, but permitted dredging in September. The

fishing was indifferent so long as the boats were confined by weather to the old beds, but improved when the new grounds became accessible.

1869 is the last year in which a special report was received from Mr. Maher, and it is incomplete. The spring season, from the 6th January to 30th April, yielded 13,702 barrels, value £12,148, average price 17*s*. 9*d*.; 5,854 barrels were despatched to Dublin, Clontarf, and Sutton; and 7,848 to London and Kent. About 106 to 108 boats were engaged in the fishery. Subsequent reports contain no mention of the disposal of the oysters, so that it ceases to be possible to ascertain what foreign buyers were operating, nor is it certain during what period the local fleet was augmented by boats from Jersey and elsewhere. I have heard, however, from an old fisherman, that French and Dutch,* as well as English buyers, were at Arklow in 1869. Supposing the preceding returns to be approximately correct, it is evident that some additional allowance should be made for home consumption, and, perhaps, as I have noted above, for oysters taken by Jersey boats to their own ports.

In 1869 an Order in Council prohibited dredging within twenty miles of a line drawn from Lambay to Carnsore Point between 30th April and 1st September, the inshore beds having been similarly dealt with by the close season order of the previous year. There is no evidence that the greater part of this area was ever fished or positively known to be worth fishing, but the very serious depletion of the known grounds appears to have been universally acknowledged. In 1870 the price per barrel was 15*s*. to 20*s*., the fishery being noted as declining.

In 1871 the price was from 13*s*. to 18*s*., the take being less than that of the previous year. An oyster company was formed, but of its subsequent fate I have no information. It is evident that in this year defective harbour accommodation interfered with all branches of fishing.

In 1872 the catch was returned at 16,000 barrels, price 16*s*. to 20*s*. The fishery was not improving, and no recent discovery of new beds was reported. During the next few years the reports are not of an encouraging nature. Some private beds acquired under license remained neglected, and indeed the conformation of the coast and the small rise and fall of tide offer little promise to this form of enterprise.

In 1873 the catch was 13,640 barrels, value £13,000, price 16*s*. to 22*s*. In 1874, 7,520 barrels, value £7,236, price 18*s*. to 24*s*. 6*d*. The number of boats dredging is stated to have varied from 12 to 240.

24*s*. 6*d*. per barrel is the highest price mentioned in the official reports during the course of the fishery, but the statements of old fishermen mention higher prices. Thus in 1865 the average price given in official returns is 13*s*., but I have heard it stated that as early as February in this year the price reached 20*s*., and became 24*s*. later in the year, touching 29*s*. on one occasion. The same price is said to have been paid in 1869, the average price given in the official return being 17*s*. 9*d*. The earnings during this period are said to have been from £2 to £5 per week per man, and, allowing for reduction from gross to nett, with some margin for lapse of memory, it is evident that in the late sixties the fishery was a fair means of subsistence.

* Dutch buyers ceased operating in Scotland in 1871.

In 1875 the catch was 9,622 barrels, value £9,426, average price 19*s.* 7*d.*

In this year reports as to the existence of new grounds off-shore "at a greater distance from land than those frequented by the" "dredgers" caused the Inspectors of Fisheries (who succeeded the Inspecting Commissioners in 1870) to obtain "the use of H.M.S. "'Goshawk' for the purpose of making investigations." They "provided suitable dredging apparatus, and sent an experienced" "dredgerman on board to conduct the operations. The result of" "the investigations, carefully carried out by the commander, was" "such as to satisfy" the Inspectors "that no amount of oysters," "worth the trouble of dredging for, existed at the place indicated." "Some investigations carried on more northward met with a simi-" "lar result." The grounds explored comprised the neighbourhood of the Kish Bank, whence an employé of the Lights authorities seems to have carried a tale of oysters to the ears of Arklow. The gunboat also dredged outside the banks from Dublin to Blackwater, and northwards along the coast as far as Belfast Lough. A new ground was reported this year off the Blackwater.

In 1876 the value of the catch is returned as less than £7,000. Some spat was imported during this year, but it all died. Reference is made in this and in succeeding years to the observation of spat on the beds, the reports being generally unfavourable.

In the period from 1877 to 1881 the catch shows a gradual decline, 8,706 to 2,609 barrels, the value from £8,706 to £4,313, the average price fluctuating between 13*s.* and 20*s.*

In 1883 the output was 765 barrels, value £863, average price 22*s.* 7*d.* In 1887, the next year for which a return is available, the output was 526 barrels, value £313, average price 12*s.* The output rose to 1,040 barrels in 1888, but the average price fell to 10*s.* 8*d.*, the value being £550. The takes in 1891 and 1892 are not given; but as the values are returned at £1,029 and £1,100 respectively, the output must have shown a considerable revival.

In subsequent returns the oysters are given in hundreds instead of barrels, and these returns include all oysters taken within the Wicklow Coastguard, whereas the previous reports referred only to Arklow (and Courtown, since Courtown boats landed their oysters for sale at Arklow). A comparison is therefore impossible, but the decadence of the industry is shown by the fall from 13,032 hundreds in 1894 to 898 hundreds in 1899, the price quoted in the latter year being 3*s.* 3*d.* per hundred. At 20*s.* per barrel of 4½ hundreds, the price would be about 4*s.* 6*d.* per hundred, which would seem to be about the average price in the prosperous years of the industry.

In 1879 Arklow men petitioned for an extension of the open season, to enable dredging to be carried on in fine weather on supposed productive ground further to seaward than the beds which were worked at that period. H.M.S. cutter "King George" was sent to Arklow to superintend dredging experiments, which were carried on for three days by one boat in water from 14 to 30 fathoms, with the following result:—

4th September,	6 dredges,	369	oysters.
15th „	8 „	1,052	„
16th „	8 „	701	„

All the oysters are described as fine, but no small ones or spat were found. The ground explored was between the South Arklow and Blackwater Lights, and shorewards to the neighbourhood of Glasgorman Bank.

"The experiments proved that oysters are to be found outside" "the grounds usually fished, but whether in sufficient numbers to" "prove remunerative to fishermen at such a distance from the" "shore, would appear to be questionable." The Inspectors doubted whether the inshore beds could be adequately protected if the seaward beds were opened during May. In the end they refused to extend the open season, and made a by-law prohibiting the removal of oysters of less than two inches from the beds between Wicklow Head and Raven Head.

In 1882 reference is made by the Inspectors to the decline of the fishery, which is ascribed to over-dredging and to the failure of spat for many years.

In the old days we hear of a boat catching thirty and even seventy barrels in twenty-four hours' fishing, and, even if we are inclined to regard these statements with some little doubt, it is evident that before the "eighties" the supply must have so far diminished that the maintenance of price was no real compensation to the fisherman. It is equally evident that the demand continued fair for some time during the decline of the industry, but as the price was not enhanced in face of the diminished supply, it may be taken that the demand was slackening. That the hardship entailed by shortage of supply was not of an immediately pressing nature is to some extent accounted for by the discovery, as one may term it, of the spring mackerel fishery, to which the energies of Arklow began to be diverted in the year 1872, and which, in the course of the next ten years, became a regular industry for Arklow boats. To prosecute this new industry, a fleet of powerful boats was equipped at Arklow, largely by means of loans administered by the Fishery Office—which loans, it may be added, were, with very few exceptions, punctually repaid.*

* Complaints which have been made in public of harsh treatment by the Office of Irish Fisheries of Arklow fishermen who obtained boats by loan, seem to be effectually disposed of by the following statement of facts, which relate to the only boats taken from the borrowers :—

Boat—	"True Light."	"Two Brothers."	"St. Peter."
Amount of Loan, ...	£500.	£500.	£500.
Repayable in, ...	8 years.	8 years.	8 years.
Half-yearly instalment, ...	£34 17*s.* 4*d.*	£34 17*s.* 4*d.*	£34 17*s.* 4*d.*
Expiring, ...	November, '96.	November, '96.	March '97.
Sold in, ...	June, '95.	January, '96.	January '96.
For, ...	£275.	£300.	£300.
At a loss of, ...	£58 3*s.* 7*d.*	£70 7*s.* 4*d.*	£105 4*s.* 8*d.*
Last payment made before sale.	July, '93.	December, '93.	July, '93.
Total repaid, ...	£209.	£176.	£139.

Now, whatever be the reason, the spring mackerel fishery has become uncertain, and has proved of recent years a speculation of most doubtful value. Arklow men, in distinction to most other Irish fishermen, have nothing to look to except the sea, and their attempts to face the situation by deep-sea trawling appear to have been frustrated by difficulties which are likely to remain unsurmountable. It is natural, therefore, that they should look to the oyster trade as a possible resource, but the circumstances have so far changed that it may be doubted whether their hopes are at all likely to be realised. Supposing even that the beds had completely recovered after the comparative immunity which they have enjoyed for a number of years—a supposition which, with all due deference to the opinion of Arklow, I think is not justified by the facts; we have still to face a condition of demand entirely different from that which formerly prevailed.

Price alone does not furnish an exact guide to the market, since prices do not exactly follow the demand, but are to some extent guided by the cost of production. The price at present obtainable for Arklow oysters seems to vary from about 2*s*. 6*d*. to about 4*s*. 6*d*. (or a little more), per hundred on the quay, and is thus not much, if at all, less than in the days when the fishery flourished. But the few buyers now operating are only able to handle a very limited output for local consumption, and outside buyers show no disposition to deal. The typhoid scare of 1895 had a most disastrous effect upon the oyster demand generally, and injured the product of absolutely safe beds not materially less than those upon which suspicion might with some show of reason rest.* The partial recovery which was noticeable in the last few years is again threatened by a recent outbreak of typhoid, supposed to be traceable to an oyster-laying in the South of England.

But supposing the demand revive, as we may reasonably hope it will, Arklow oysters have now to face competition absolutely unknown in the great days of the industry. At that time the Continental beds appear to have been almost completely exhausted, and so far from contributing anything to the London market, France† and Holland were importing Irish oysters not only for providing parent stock for their home beds, but for immediate sale for consumption. I do not know that Arklow oysters were much employed for the latter purpose, but at least one brand of Irish native, now hardly cultivated, seems to have had a great reputation in Paris. The English beds, as one may judge from the Report of the Irish Oyster Commission, 1871, and from contemporary literature generally, were not well stocked; and, as we have seen, English merchants were among the largest buyers at Arklow. Now, thanks to the success of cultural work, impossible in the case of deep-sea beds like those with which we are now dealing, France can supply the British market with an apparently unlimited number of brood and oysters suitable for relaying, as well as oysters fit for immediate consumption. The latter have averaged about 5*s*. per hundred since their first introduction to the London market. The price of the most expensive grades of the brood is only about 15*s*. 6*d*. per thou-

* *cf*. the average price of English natives—1891 to 1896, 20*s*. per 100; 1897 to 1903, 17*s*. per 100.

† Consignments were received from France as early as 1866, but the amount, prior to 1872, was inconsiderable.

sand (of 1,050),* the cost of transport being inconsiderable when large quantities are handled. French oysters, relaid on English beds until fit for consumption, can be sold wholesale at Billingsgate as low as 4*s.* per hundred, the average price being, I believe, about 6*s.* Holland, formerly a customer of Arklow, can supply oysters for relaying at about 28*s.* per thousand, apparently in any quantity, while the largest cultivated class, fit for table, make 6*s.* 6*d.* to 9*s.* per hundred.† Falmouth, whither went, as we have seen above, at least one large consignment from Arklow, makes now a large output for relaying at 13*s.* per thousand, and the various natural beds about the mouth of the Thames appear now to produce sufficient stock to admit of the sale of brood at very low prices.

To turn to Ireland, the Tralee public bed now produces a few million oysters per annum, the price paid to the dredgers not exceeding 1*s.* 6*d.* per hundred, a considerable proportion being fit for immediate consumption. The price, to the dredger, of Carlingford natives, which have a high table repute, fell to 3*s.* 6*d.* last season. and the Clarenbridge output this year sold at 4*s.* 6*d.* The Cork dredgers, who have a large market close at hand, get about 4*s.* per hundred, and here and there along the coast, where there is the remnant of a natural inshore bed, the dredgers and pickers are able to dispose of their small catches locally at a fair price.

Now, all the classes of which I have made mention are either immediately marketable for table purposes or of a quality to make high-grade oysters after relaying on a fattening bed, yet the best of them, which find their way to Billingsgate as Irish natives, have recently been quoted wholesale as low as 6*s.* to 7*s.* per hundred.‡ Arklow oysters, however, are of a different class, a very considerable proportion of the catch being at present too large for any but cooking purposes, while of the smaller ones many are very poorly fished in comparison to the size of shell. The classes which most nearly resemble them, and with which they would come into competition in the London market, are, as I am informed, the ordinary North Sea common oyster (Deep Seas), Mumbles oysters, Capes (or large oysters caught on the French side of the Channel), and Boston oysters.§ These are all used for sauce, except in a few shops where they are used as large seconds. The market price of all these oysters for the last few years has been 3*s.* 6*d.* to 6*s.* per hundred, but a few extra good make 8*s.* Americans, first imported to England about 1875, and first mentioned as relaid in Ireland in 1888, must be considered as most formidable competitors with any coarse native oyster. Even after relaying they have been quoted as low as 3*s.* 6*d.*

* *Viz.* Arcachons, 35 to 36 kilo. per 1,050. Aurays, yearling brood, cost 4*s.* 8*d.* per 1,050.

† Nearly five millions were sent from Holland to England alone in 1894. They first came into the London market, as I am informed, in 1875–6, fetching up to 18*s.* per hundred. A high price was maintained until about 1900, after which a temporary deterioration in their quality and an improvement in the supply of English natives combined to materially reduce the price, which has been known to fall as low as 2*s.* 6*d.* per hundred. From 1896 to 1901 the importations have averaged 356 cwt. a year.

‡ It goes without saying that much larger prices are got by direct supply to the consumer or caterer, but I think it is a question whether there could be established connection of this kind sufficiently extensive to be of much importance to a very large fishery.

§ Deep-sea Dutch oysters, from the Terschelling grounds were first brought to the London market about 1880, but I understand not many are now received there.

per hundred. Of late years the annual importation has averaged about 84 millions, a number which was largely exceeded previous to the 1895 scare. For soup and cooking purposes generally oysters have not of late been in much demand, and for such a market the large Arklows would have to face the competition of Portuguese (imported since 1881 in large numbers—about 20 millions a year of late), at 2*s.* 6*d.* to 3*s.*, or less, as well as of the kinds already mentioned and of Americans.

Though, as I have already mentioned, the quality of the Arklows might possibly be improved by constant dredging, if the supply held out long enough to make continued work profitable, it does not seem probable that the present state of the "commons," etc., which have been well dredged for a considerable period, would be surpassed; and from all the facts of the market known to us, I doubt if unsorted Arklows would command a higher price. Relaid on beds which proved to suit them, it is possible that their price would suffer from the coarse appearance of the shell, and against whatever might be the increment in saleable value must be placed the rent of beds, cost of transport and cultivation, and loss from mortality. These expenses would of course be lessened if the work were carried out on the co-operative principle proposed by the Arklow men, but must still be reckoned as not inconsiderable.

I have found by experiment on various beds on the West coast of this country that Arklow oysters are capable of acquiring the distinctive flavour of a good bed and of making a very fair fish, and it is probable that they would do better still in some of the rich estuarine beds which I have not had an opportunity of testing. There is, however, a complaint from the London market that Arklow oysters arrive weak; because, in the ordinary course of the trade, they have hitherto been sent in bags and have got dry in transit. Samples which we have sent, properly packed in barrels, to the English markets, are reported to have arrived in excellent condition; but, as the expense of retnrning empty barrels is considerable, the cost of the barrel, as well as the freight, must be deducted from the profits of the consigner. Even with all possible precautions of packing and rapid transit, I have found the larger oysters of consignments particularly liable to mortality soon after arrival, if relaid for fattening. It is probable that this might to a large extent be obviated were it possible to adopt the French system of "education," under which oysters destined for considerable journeys are believed to learn to close their shells tightly by gradual exposure on different levels of the foreshore from near low-water mark upwards. Certainly oysters so treated arrive very strong, but the contamination of the river Ovoca renders the adoption of this principle impracticable at Arklow itself, while the nature of the coast does not offer facilities in the immediate neighbourhood. It might be done at Courtown, but that port would not suit the big Arklow smacks. The difficulty might be got over by a frequent cutter-service to store or relaying beds, but unless there is a full cargo for the cutter every day or few days, the extra expense would not seem likely to be compensated by the improved vitality of the oysters. Moreover, as there seems to be little demand for these very large oysters, it would seem better to return them to the beds to spat than to spend money on "educating" them. Oysters of medium size, properly, *i.e.*, very tightly packed, deep shell down, in barrels or boxes seem to travel well enough without "education."

In the case of a direct supply to market a difficulty is likely to arise as to the size of oysters and their condition. Merchants appear most unwilling to take unsorted lots, including an unknown number which are too large to be of much use, coarse or sponged, or "clods," *i.e.*, adorned with a mass of "mums" (*Sabellaria alveolata*), often much exceeding the weight of the oyster. On the other hand the fishermen, as I am given to understand, object to sorting; and this objection, while tending to unduly reduce the price in any sort of transaction, might prove an entire bar to any dealings with those relayers who handle only table oysters of moderate size. It appears that there is a demand from this class of customer for direct deep-sea oysters of medium size, though it is not certain that the price would be satisfactory to the dredgers.

I have been told by Arklow fishermen that they do not consider it would be worth their while to dredge for less than 4*s.* 6*d.* per hundred unsorted; and the aspirations of Courtown are about the same, though it seems that something in the nature of a contract to take all oysters delivered is there more desired than a rise on recent prices.

It is, however, to be feared that the facts as to competition and price, as put forward above, are not calculated to lead to the belief that so high an average price would be obtainable unless the market materially improve or foreign supplies slacken. Small consignments which we have sent to the London and Liverpool markets have not, in all cases, even paid the expenses of carriage and barrels. Larger consignments would, *pro rata* to the number of oysters, show a less heavy charge for these items; but the market is at present very shy, and whenever it recovers there must surely be a large accumulation of higher grade oysters to be worked off at a comparatively low figure, with a result prejudicial to Arklows, even if relaid on an English fattening bed.

It is obvious that if a boat could now take thirty barrels (say 120 hundreds), as alleged in the old days, there would be a fair living even at 1*s.* per hundred, making allowance for weather and the close season. I cannot convince myself that such a take is approximately possible even on the Ballyvaldon bed; much less that the beds as a whole are capable of furnishing a continued supply to such a fishery as would be entailed by diverting to dredging the fleet which is now occupied with mackerel in the spring and herring in the autumn. We know the effect that a large dredging fleet had in the past on a supply which I believe to have been incalculably greater than that which now exists; and though the Inspectors, in a report to which attention is drawn above, considered that the decline was in part due to failure of spatting for many years, it appears that such failure is a necessary consequence of over-dredging. The amount of spat occurring on any fishery seems to be in direct proportion to the amount of parent oysters, and, although even on poorly-stocked grounds exceptionally favourable circumstances of weather may at rare intervals allow a considerable fall of spat, it is only in those places in Europe where the natural bulk of spawning oysters is maintained that heavy spatting is a feature of regular occurrence.* Moreover, while within certain limits dredg-

* *cf.* Bashford Dean, Bull, U. S. Fish. Comm. XI., for 1891, 1893, p. 402: also, for an exhaustive account of the circumstances which led to the extinction of the Firth of Forth fishery—Fulton, 14th Ann. Rep. Fish. Bd. Scot., 1893, Pt. III., p. 243.

ing is without doubt beneficial to some beds (though, probably, not to all), if carried to excess it may result in such an alteration of the bottom as to favour the irruption of sand and lessen the productive area. Whether some such cause has resulted in the present barren (though clean) condition of some East coast grounds, once well stocked and long unmolested by man, is a matter upon which I cannot offer an opinion.

In concluding this section of the Report I must express to Mr. J. Wrench Towse, Secretary to the Worshipful Company of Fishmongers of London, my indebtedness for much of the information as to imports and prices in the London Market which I have incorporated above. I have also to thank Mr. George Tabor, of Billingsgate Market, for similar assistance.

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iii.—SURVEY OF BEDS.

Arrangement of Records.

The positions were fixed in the usual way by cross-bearings at the beginning and end of each haul, but are indicated below by the bearings and distance of the nearest convenient object on the chart, and by the direction and length in miles and cables of the haul.

Although for the purpose of this report the hauls have been grouped in sections according to their locality, they are numbered as in my manuscript records, to avoid confusion with future work. I propose when the ground has been surveyed in greater detail to prepare for publication a chart on which each haul will be marked.

In the case of most of the hauls a note was made of every kind of animal brought up by the dredges, but at present reference will only be made to those animals which, for the reasons set forth below, seem to be of importance in connection with the oyster fishery.

The common starfish, cross-fish or five fingers (*Asterias rubens*) is a notorious destroyer of oysters, which it has the power of opening by a continuous strain applied by means of the suckers on the underside of its "arms" upon the two valves of the shell, subsequently devouring the "fish" by protruding its stomach between the valves. That a starfish can exert sufficient force to open a perfectly healthy full-grown oyster seems to me doubtful, but I have dredged on these grounds full-sized oysters which bore in the semi-macerated condition of the "fish" evident signs of having been so opened. Oysters for re-stocking or relaying, arriving weak after a long voyage, appear to be an easy prey to starfish, and though the latter can certainly open small oysters even when healthy, it would seem probable from the company in which they were mostly found on the eastern grounds that starfish there prey chiefly on beard mussels (*Mytilus barbatus*) and a small bivalve (*Nucula nucleus*), resembling a cockle in shape but smooth and dark brown externally. The latter seemed to be everywhere plentiful in coarse sand or gravel, but was seldom seen unless one of the heavy dredges brought up a load of soil.

Certainly we found starfish in much greater numbers on barren ground, such as the Point beds, than at Ballyvaldon, though a good many oysters there were opened by starfish.

Beard mussels, besides nourishing a crop of starfish, and so endangering the welfare of oyster spat which might settle in their vicinity, are probably inimical to the beds owing to the dense masses which they tend to form there, favouring the settlement of silt and mud on ground otherwise suitable to oysters. In regard to common mussels, very scarce on deep-sea beds but frequently abundant in estuaries, I have known it to be asserted that starfish, by keeping down these mussels, compensate for any depredations which they make on the oysters themselves.

Sun-stars, animals like starfish, but having about thirteen instead of five arms, are not known to attack oysters, but, on the contrary, devour starfish and whelks.

Whelks (*Buccinum undatum*) are reckoned among the enemies of the oyster, being able to bore through its shell.

Almond-whelks, queen-whelks or smooth whelks (*Fusus antiquus*), distinguished from common whelks by having a smooth instead of a corrugated shell, have a ribbon-saw of teeth not very dissimilar from that of the common whelk, but as they appear to attain their greatest size on grounds where there are no oysters and apparently few bivalve shell-fish of any sort, I think it is improbable that they can be regarded as enemies of the oyster. I have nevertheless noted their occurrence in the records which follow.

Borers (*Murex erinaceus*), small whelk-like animals, with strongly marked knobbed ridges on the shell, are perhaps the most deadly foes of young oysters on the inshore grounds, where they are chiefly found. They appear, however, to be rare on the beds with which we are now dealing, but, being small, might often pass through the chain-net of the dredge and so escape detection.

Crabs of several kinds occur on the eastern beds, but none, I think, are of much importance in this connection. The shore-crab, so common between tide marks, is a serious enemy of young oysters, but is not found on the grounds with which we are dealing. Hermit-crabs or "peely-men"* (*Eupagurus bernhardus*) are, so far as I know, harmless.

The honey-comb-like masses of sand, called "mums" by the fishermen of this coast, are built by colonies of worms (*Sabellaria alveolata*), and are detrimental to a bed in two ways. In places where the worms find a suitable home they appear to cover with their architectural efforts every spot suitable for the settlement of oyster spat, and very probably choke any old oyster that may be there. On some other grounds, where they do not settle in great quantity on anything else, mums choose for the foundation of their house the deep shell of a living oyster, and upon it raise such an edifice of sand that the shape of the whole may be practically a hemisphere. An oyster so "mummed" is known as a "clod,"† and though it does not appear to suffer from its burden, it has little market value until cleaned,—a somewhat laborious occupation. The boring sponge (*Cliona*) honey-combs and disintegrates

* Arklow.

† On the West Coast I have found the word "clod" in use for an old oyster with very thick shell, such as seems to be known at Arklow as an "old man." In this report "clod" is only used to denote a heavily mummed oyster.

the shell, rendering the oyster so unsightly as to be only marketable for cooking purposes. A worm (*Serpula*) forms a hard white curved tube on stones, shells, and other objects, and sometimes encrusts the shell of a living oyster almost to the same extent as mums. Such encrustation is very heavy and very difficult to get off, but a few of these tubes are not of importance. Their presence on dead oyster shells seems to be looked upon as a good sign of a ground, whereas old worn clean shells are held to denote that the ground is not presently suitable for living oysters.

Sea squirts (*Ciona intestinalis*) in moderate numbers are also held to denote good ground, but cause some trouble in removal from oysters destined for market.

Crows, saddle-backs, miesalauns, arigalauns, or howsoever known (*Anomia ephippium*), I have not noted below as they occur everywhere, and are not, that I know of, harmful, except for the trouble involved by their removal from the oyster. If left on, they die very quickly, and, by putrefaction, injuriously affect oysters raised or dumped for market.

LIST OF HAULS.

N.B.—"Dredge" means a dredge of ordinary Arklow pattern. "Large dredges" refer to dredges specially made for us at Arklow on the recommendation of experienced fishermen for deep-water work. They are about five feet, three inches on the sword, and very heavy.

INSHORE BEDS.

Section 1.

MIZZEN HEAD.

Station 1.—1·35 mi. S. by W. of Wolf Rock. Towing N.N.E. ¼ E. 1·1 mi.

2 dredges, ... Oysters, 1.

A rough ground, as indicated by the quantity of stones in the dredges. Old oyster shells present in moderate number. Starfish and sun-stars fairly plentiful, the former probably feeding chiefly on beard mussels, which appeared, from the fair number of living examples and great quantity of empty shells, to have been plentiful. Whelks numerous, but small. The result of the haul is confirmatory of the opinion expressed by Arklow men that the region is too rough for dredging, and as there was no indication of a good supply of oysters it was not further explored.

Station 2.—0·8 mi. S.E. by E. of Mizzen Head. Towing N.N.E. ¼ E. 1 mi.

2 dredges, ... Oysters, 9.

Stones, shells, and stiff muddy sand. Many old oyster shells. Several starfish, many beard mussels, a fair quantity of small whelks and of almond whelks.

Station 3.—In continuation of Station 2. Towing in same direction 1 mi.

1 dredge, ... Oysters, 25.

Stones and a large quantity of mums, but my notes give no indication that the oysters were "clods" (*i.e.*, encrusted with mums). Oyster shells numerous, both old and recently emptied. Only two starfish; several sun-stars; not many beard mussels.

Two dredges were shot here, but one came fast as soon as shot, and was lost.

Station 121.—0·9 mi. E. ½ N. of Mizzen Head. Towing N.E. by N. ½ N. about 0·7 mi. 10¼ fath.

3 dredges, ... Oysters, 21.

A few stones, many oyster shells, one starfish, one sun-star, two bunches of beard mussels.

Station 122.—0·6 mi. E. ¼ S. of Mizzen Tower. Towing N.E. by E. ½ N. about 0·6 mi. 10½ fath.

3 dredges, ... Oysters, 31.

Starfish fairly plentiful, several sun-stars. No "mums" in this and preceding haul.

Station 4.—2·1 mi. S.E. by S. ¾ S. of Mizzen Head. Towing W.N.W. ½ W. 1·7 mi.

2 dredges, ... Oysters, 25.

A few stones, and many oyster shells. A few sun-stars, small whelks, almond whelks, and beard mussels.

Station 5.—1·7 mi. S.S.W. ¼ S. of Mizzen Head. Towing N. ¾ W. 1·6 mi.

2 dredges, ... Oysters, 17.

Much the same as Station 4 in regard to the bottom, and refuse catch, but a few starfish also present.

Station 6.—2 mi. S.S.W. ¼ S. of Mizzen Head. Towing N.W. by N. 1·6 mi.

2 dredges, ... Oysters, 2.

A great quantity of mums, and comparatively few oyster shells. Beard mussel shells fairly plentiful, but no living mussels. Whelks and almond whelks fairly plentiful.

Station 50.—1·7 mi. E.S.E. of Mizzen Head. Towing N.W. ¾ N. 1·5 mi., 9 to 11 fath.

1 dredge,	...	...	...	Oysters, 2.
1 large single dredge,		...	...	Oysters, 19.

A few stones. Starfish very numerous; sun-stars fairly plentiful; many beard mussels; a few whelks and almond whelks.

Three other dredges shot on this haul did not appear to have been fishing properly.

Station 51.—3·2 mi. S.S.W. ¾ W. of Mizzen Head. Towing S.E. by S. 1·8 mi., 13½ to 13 fath.

1 dredge,	...	...	...	} Oysters, 1.
1 large single dredge,		...	...	

A few stones and two lumps of mums. The greater part of the ground covered was evidently sandy and unsuitable for oysters.

I consider that oysters are present in some number in isolated patches within a circular area about 2·4 mi. in diameter, of which the centre is about 1·4 mi. E. by S. ¼ S. of Mizzen Head, but it is evident that even within this area they are not widely distributed in quantities. The ground is rather full of hitches, to avoid which, according to our pilot, James Craan, it is necessary to keep Arklow chimney outside Mizzen Head; but a good number of oysters (*cf.* Stations 3, 121, 122) seem to be on the inner part. Indeed the ground known as "Jack's Hole," which has been worked by Arklow boats in 1902 with considerable success, seems to extend quite close into the shore. Fifty oysters per dredge in an hour's work has been mentioned to me as a fair catch on this ground, which lies from ½ mi. to 1 mi. N.E. of Mizzen Head, and extends along the coast about half-way to Jack's Hole.

In saleable quality the oysters compare well with the average of any ground further south. They are mostly clean and fairly regular in shell, though a good many are old and thick, and perforation by sponge is not infrequent. In the best examples, ranging from about 3½ to 4¼ inches across the shell, the weight of the fish averages 14·36 gr., that of the shell 160 grammes.

I found no indication in 1901 that the beds were in process of maintaining their stock, as the smallest oysters which we got, even with a fine mesh net in the dredge, were probably not less than three years old. To some extent this may be due to want of dredging having permitted accumulation over much of the area of beard mussels, which seem to support a large stock of starfish. There were a few very young oysters among those taken by Mr. Farran at Stations 121 and 122 early this year.

SECTION 2.

ARKLOW BAY.

Station 82.—0·7 mi. S. by W. ¾ W. of Ennereilly River. Towing S.W. by S. 1 mi., 7¼ fath.

2 dredges, ... Oysters, 33.

There is no record of the nature of the hottom in this haul, which was made hy Captain Macauley.

Station 7.—1 mi. S. ½ E. of Redcross River. Towing S.W. by S. 1·2 mi., 8 fath

2 dredges, ... Oysters, 7.

Some stones and many oyster shells. A few sun-stars, several beard mussels and almond whelks. Whelks fairly plentiful. One horer (dead shell only). Several of the oysters were "clods" (*i.e.*, encrusted with mums), hut there was no other appearance of mums on the ground.

Station 8.—In continuation of Station 7. Towing S.W. ¼ W. 1·1 mi., 8 fath.

2 dredges, ... Oysters, 10.

Ground much the same as last. The larger oysters were "clods."

Station 12.—1·1 mi. S.E. ½ E. of Arklow Pier. Towing N.N.E. ½ E. 1·3 mi., 7 to 9 fath.

2 dredges, ... Oysters, 4.

Many stones and a little dark blueish clay. Many oyster shells. Several starfish, a few sun-stars;, whelks and almond whelks fairly plentiful.

Station 13.—1·2 mi. S.E. ½ S. of Ballymoney River. Towing N.E. ½ N. 1·5 mi., 8 to 9 fath.

2 dredges, ... Oysters, 23.

Many stones. Starfish fairly plentiful; several sun-stars, etc., as in last haul.

Station 83.—1·9 mi. S. ¼ E. of Ennereilly River. Towing S.W. hy S. 1 mi., 9 fath. (?).

2 dredges, ... Oysters, 0.

Sand, shells, and stones on lead.

Station 11.—1·6 mi. S.E. ½ S. of Arklow Head. Towing N. ¾ W. 1 mi., 8 to 10 fath.

2 dredges, ... Oysters, 0.

Sandy ground, with a few stones and some oyster shells. Several whelks.

Station 15.—In continuation of Station 14. Towing S.W. ¾ S. 1·2 mi., 9 fath.

4 dredges, ... Oysters, 0.

Many stones and oyster shells. Several starfish. Whelks fairly plentiful, large. A few lumps of mums.

Station 14.—1·3 mi. S.E. ¾ S. of Redcross River. Towing S.W. ¾ S. 1·5 mi., 9 fath.

3 dredges, ... Oysters, 0.

Many old oyster shells. One starfish and two sun-stars. One horse mussel, a few whelks, and almond whelks.

Station 9.—2·5 mi. E. by S. ¾ S. of Arklow Pier. Towing S.W. ¼ W. 1·6 mi., 8 to 10 fath.

2 dredges, ... Oysters, 1 (a clod).

Many stones, few oyster shells. Large quantity of mums. A few whelks.

Station 16.—2·9 mi. S.E. ¾ S. of Arklow Pier. Towing N.E. ¾ E. 1 mi., 13 to 12 fath.

4 dredges, ... Oysters, 0.

A sandy ground, with a few oyster shells and stones, the latter encrusted with mums.

Station 52.—3·9 mi. S.E. by E. ¼ E. of Arklow Head. Towing N. by E. ¾ E. 2·3 mi., 14 to 11 fath.

1 large single dredge, ... Oysters, 0.

Ground apparently covered hy mums. Many old oyster shells.

Our pilot, James Craan, selected the grounds covered hy Stations 7, 8, 14, and 15, which did not prove to hold many oysters. The remaining stations I selected myself with a view to quartering all the hay. At Station 13 we found oysters in fair quantity, and I

understand that this part of the bay has since been worked, by the few small boats which now dredge, with some profit. Some hauls recently made by Mr. Farran over the same ground show a distinct improvement, but I do not consider that any part of the bay is sufficiently stocked to warrant a large fishery: though the beds show signs of recuperation, as there is a fair proportion of young oysters among the take. Seawards and to the south of Stations 12 and 13 the ground seems unsuitable, being either sandy or choked with mums. There is, however, a patch of dredging ground between Arklow and Arklow Rock (from about $1\frac{1}{2}$ mi. off shore landwards) where the Arklow boats dredge when the weather does not suit for the northern grounds, but Mr. Farran, in several hauls made recently, found very few oysters there. Northwards it does not appear that the productive ground is continued to the productive part of the Mizzen Head beds. Station 6, included in the Mizzen Head section, which comes close to Station 15 of this section, was found barren, but there may be oysters further inshore.

SECTION 3.

GLASGORMAN BEDS.

Station 20.—2 mi. E. by S. $\frac{1}{4}$ S. of Glasgorman No. 2 buoy. Towing S.S.W. $\frac{1}{4}$ W. 1·4 mi., 18 fath.

4 dredges, ... Oysters, 0.

No oyster shells. Evidently fine sand, but uneven, as the dredges hitched occasionally. No stones and no animals associated with stony or gravelly ground.

Station 10.—0·8 mi. S. by E. $\frac{1}{4}$ S. of Glasgorman No. 2 buoy. Towing S. by W. $\frac{3}{4}$ W. 0·7 mi., 14 to 17 fath.

2 dredges, ... Oysters, 0.

Small stones, gravel and broken shells. A few oyster shells. One borer, one almond whelk, several whelks, a few beard mussels. Many shells of the latter, and several shells of Nucula. My notes contain no entry of starfish.

Station 89.—2 mi. E. by N. $\frac{1}{4}$ N. of Glasgorman No. 3 buoy. Towing N. E. $\frac{3}{4}$ N. 2·1 mi., $12\frac{1}{2}$ to 16 fath.

2 dredges, ... Oysters, 0.

Stones, starfish, small shells. (Record of contents of dredge incomplete.)

Station 22.—1·3 mi. E.S.E. of Glasgorman No. 3 buoy. Estimated course N.E. ¾ N. 2·9 mi., 14 to 15 fath.

(A thick fog came on in the course of this haul, rendering it impossible to verify the position at the end of the haul).

3 dredges, ... Oysters, 42.

Small stones and shell fragments. Many oyster shells. Starfish and sun-stars fairly plentiful in first half of haul, scarcer in second half. Whelks and almond whelks fairly plentiful in first half, not noted in second half. A few beard mussels in first half, many shells in both halves. A few lumps of mums in each half of the haul, but only a few of the oysters slightly encrusted. The dredge which was last shot in second half of haul had only one or two oysters.

Station 90.—1·7 mi. S.W. by S. ½ S. of Glasgorman No. 2 buoy. Towing N.E. ¾ N. 1·6 mi., 15 fath.

1 dredge, ... Oysters,, 5

Starfish and whelks. (Record of contents of dredge incomplete.)

Station 88.—0·8 mi. E. by S. of Glasgorman No. 3 buoy. Towing N.E. by N. 2·3 mi., 11 to 12 fath.

2 dredges, ... Oysters, 2.

Stones, oyster shells, and starfish. (Record of contents of dredge incomplete.)

Station 23.—Estimated position—2·1 mi. S.S.W. ¾ W. of Glasgorman No. 2 buoy. Estimated course—S.W. ¾ S. 0·7 mi., 11½ fath. (Impossible to fix position with certainty, owing to fog.)

3 dredges, ... Oysters, 9.

Stones, sand, many oyster shells. A few starfish; several sun-stars, and almond whelks. The two dredges first hauled had only three oysters between them.

Station 116.—2·8 mi. N.E. by N. of Glasgorman No. 3 buoy. Towing N.E. ½ N. 1·8 mi., 9 fath.

2 dredges, ... Oysters, less than 9.

Oyster shells.

Station 20 is outside the ground recognised as the Glasgorman bed, and is merely one of a number of hauls made with a view of ascertaining the nature of the bottom in places as to which no information was forthcoming from our pilots. The remaining stations in this section cover at fairly close intervals the ground outside the bank between about 9 and 14 fathoms.

Station 10 was the first chosen by James Craan, and as the day was clear and marks easily visible it probably represents a site formerly productive, though now quite barren. Station 22 was also chosen by Craan, but owing to a fog which came on in the course of the haul the ground covered could only be estimated by soundings, lead of warp, tide and time. In Craan's opinion the end of the haul was "too far down among the dirt."

The oysters, though not very numerous considering the length of haul, were the finest which we found on any part of the eastern grounds. They were remarkably clean and regular in shell, and though some were very large the shell was comparatively thin. A haul nearer in to the bank than the last gave only a few oysters, and the ground proved hitchy. The remaining hauls were made by Captain Macauley at my direction, but produced little result.

I think it probable that there are a good many oysters scattered over the ground, but only in considerable quantities in isolated patches. As we found no young oysters at all, I fear the bed cannot be considered to offer much inducement to dredging on a large scale.

SECTION 4.

PASS BEDS.

Station 85.—0·5 mi. E. ¼ S. of Kilmichael Point. Towing S.W. ½ S. 1 mi., 7½ to 6 fath.

2 dredges, ... Oysters, 0.

Sandy. Some old oyster shells.

Station 86.—0·8 mi. S. by W. ¾ S. of Kilmichael Point. Towing S.W. ¼ W. 9 mi., 6 fath.

2 dredges, ... Oysters, 0.

Sandy. Some old oyster shells.

Station 87.—0·5 mi. S. by E. of Doorogue Stream. Towing 1·5 mi. S.W. ¼ W., 5½ fath.

2 dredges, ... Oysters, 0.

Sand and shells. Some old oyster shells.

Station 47.—1 4 mi. S.W. by S. of Kilmichael Point. Towing S.W. by S. 1·6 mi., 6¾ fath.

5 dredges, ... Oysters, 16.

Stones. Many oyster shells. A few beard mussels, one almond whelk; starfish fairly plentiful; sun-stars few. Mums fairly plentiful. All the large oysters "clods." Judging from contents of dredges most of the ground worked over was sandy.

Station 48.—2·7 mi. S.S.W. of Kilmichael Point. Towing S.W. ¼ W. 0·6 mi., 6 fath.

5 dredges, ... Oysters, 2.

Stones, a few worn oyster shells. One almond whelk, two starfish, one sun-star.

Almost all the ground covered by this haul was evidently sandy.

The first three hauls enumerated above were not on the part of the ground supposed to be productive, but were made with a view to seeing how far a bottom suitable for oysters extends into the narrows between Glasgorman banks and the land The actual bed, which lies inside the southern tails of the two banks, seems to be of rather small extent, as in two attempts Michael Wafer failed to locate it to his satisfaction.

I think some part of it is fairly stocked, but as it has the reputation of being peculiarly rich in "clods" it cannot be regarded as a bed that ought to be fished. We got on it a fair proportion of young oysters, and, if left alone, it should be valuable as a centre from which spat may be carried to neighbouring grounds. I understand that when oysters were sold by the barrel "clods" from this bed were considered useful, but in the present delicate state of the trade they would do more harm than good to the dredgers.

Section 5.

RONEY.

Station 99.—1·8 mi. S. ½ E. of Courtown Pier. Towing S. by W. 1 mi., 5 fath.

2 dredges, ... Oysters, 0.

Fine sand.

Station 108.—0·4 mi. E. by N. ½ N. of Glasscarrig Point. Towing N. by E. ¼ E. 1·3 mi., 7 fath.

2 dredges, ... Oysters, 8.

Sand and shells.

Station 49.—0·9 mi. E.N.E. ½ N. of Glasscarrig Point. Towing N. ½, 1·5 mi., 7 to 6 fath.

3 dredges, ... Oysters, 31.

Some stones. Starfish fairly plentiful; sun-stars few; several whelks; some mums, but not much on oysters. Five dredges were used, but two fouled, while the remainder, owing to wind against tide, did not fish very well.

Station 107.—1·1 mi. S.S.E. ¼ E. of Ballymoney Coast Guard Station. Towing S.S.W. ½ W. 1·8 mi., 6 fath.

2 dredges, ... Oysters, 0.

Very fine sand. Nothing on it.

Station 37.—1·9 mi. E.S.E. of Courtown Pier. Towing N.E. ½ N. 0·9 mi., 8 fath.

3 dredges, ... Oysters, 0.

A few small stones, but most of the ground sandy. Some old worn oyster shells.

Station 114.—1·2 mi. E. by N. ¼ N. of Roney Point. Towing N.N.E. ¼ E. 1·6 mi., 8 fath.

1 dredge, ... Oysters, 11.

Stones, sand and shells.

Station 110.—1·1 mi. E.N.E. ¼ N. of Roney Point. Towing N.N.E. 1·3 mi.

1 dredge, ... Oysters, 2.

Large stones.

Station 34.—2 mi. N. by E. ¼ N. of Roney Point. Towing S.S.W. ½ W. 0·7 mi., 7½ fath.

3 dredges, ... Oysters, 7.

Stones and old worn oyster shells. One starfish, one sun-star, one almond whelk. Mums fairly plentiful. Most of the oysters were "clods."

Station 113.—1·6 mi. E.S.E. ½ S. of Roney Point. Towing N.N.E. ¼ E. 1·5 mi., 9 fath.

2 dredges, ... Oysters, 4.

Stones. Some starfish.

Station 111.—2·5 mi. E. by S. of Cahore Point. Towing N.N.E. ½ E. 1·8 mi., 12½ fath.

1 dredge, ... Oysters, 1.

The dredge full of oyster shells.

Station 35.—3 mi. E. ¼ S. of Roney Point. Towing S.S.W. ½ W. 0·8 mi.

3 dredges, ... Oysters, 0.

Many stones; some large. A few oyster shells. One starfish, one sun-star; a great quantity of mums.

The real Roney bed was dredged in Station 49. According to Wafer, it had for many years been worthless, but was showing signs of recovery. This our haul to some extent confirmed, as we got a fair number of oysters (considering how badly the dredges appeared to be fishing), and they comprised a certain proportion of young ones. The "quarry," inaccessible to the "Helga," lies close inshore S. of the Roney rocks, and was said to have held a fair stock of oysters up to a few years ago, when they began to get scarce. The bed seems to have since been left alone.

Our numerous hauls outside the Roney were made in the endeavour to locate some once productive grounds, including the "Cuckoo's Nest." Although we got a few oysters here and there it does not seem probable that there is any well-stocked ground of important extent in the neighbourhood.

SECTION 6.

POINT BEDS.

Station 41.—0·4 mi. N.E. by E. of Sluices Buoy. Towing S.W. by S. ¼ S. 0·9 mi., 8 to 9 fath.

4 dredges, ... Oysters, 9.

Stones. Starfish very numerous; several sun-stars, one whelk. Mums fairly plentiful, but not noticed on oysters.

Station 42.—0·8 mi. E. by N. of Sluice's Buoy. Towing S. by E. ¼ E. 1·3 mi., 9 fath.

5 dredges, ... Oysters, 91.

Stones and small gravel. Starfish fairly plentiful; a few sun-stars, one whelk. Several clusters of mums. No "clods" noted.

Station 43.—1·9 mi. S.E. by E. ¼ E. of Poulduff Pier. Towing S.S.E. by E. 2·1 mi., 11 fath.

5 dredges, ... Oysters, 17.

Stones; oyster shells. Some beard mussels attached to oysters. Starfish very numerous; sun-stars few; a few whelks. Several clusters of mums, and some on oysters, but not enough to make clods.

Station 109.—0·5 mi. E. of Cahore Point. Towing N.N.E. 1·4 mi., $8\frac{1}{2}$ fath.

2 dredges, ... Oysters, 0.

Large stones, sand, and shells.

Station 112.—1·2 mi. E. by N. of Cahore Point. Towing N.N.E. $\frac{1}{4}$ E. 0·5 mi., $9\frac{1}{2}$ fath.

2 dredges, ... Oysters, 4.

Stones. Starfish.

The last two hauls belong perhaps rather to the grounds which I have placed in the Roney Section, hut they are evidently not of much importance.

Station 42 passed through a part of the Point hed, which seems fairly well stocked, but as the 91 oysters taken included only two young, it cannot he said to be in a very satisfactory condition. An extraordinary number of starfish characterised Stations 41 and 43, which seem to have heen about the margins of the bed.

Section 7.

COPPER BED.

Station 44.—2 mi. N.E. hy N. of No. 1 Blackwater Buoy. Towing S.S.W. $\frac{1}{4}$ W. 1·6 mi. $12\frac{3}{4}$ to 15 fath.

3 dredges, ... Oysters, 6.

Stones and a very large quantity of old worn shells. A few starfish and sun-stars; one almond whelk; a small quantity of mums. None of the oysters were "clods."

Station 106.—2·1 mi. N.N.W. $\frac{1}{2}$ W. of Blackwater Light. Towing S.W. by S. 1·4 mi., 16 fath.

2 dredges, ... Oysters, 0.

Stones and old oyster shells.

Station 46.—1·3 mi. N. by E. of Blackwater No. 1 Buoy. Towing S.S.W. $\frac{3}{4}$ W. 1·9 mi., 19 fath.

5 dredges, ...
1 large dredge, ... } Oysters, 0.

A few stones, some large. Some old worn oyster shells. A few starfish. Mums fairly plentiful in first part of the haul. Most of the ground covered was evidently sandy.

These hauls were made in search of the Copper Bed, which does not seem to have been worked for a good many years, and was always of very limited extent. Of the few oysters we got most were fine shelled, hut thers were no young ones.

SECTION 8.

SHELL BEDS.

Station 62.—0·6 mi. W.N.W. ½ N. of No. 1 Blackwater Buoy. Towing S.S.W. ¼ S. 0·8 mi., 7 to 3 fath.

4 dredges, ... } Oysters, 0.
1 large dredge, ...

A few worn oyster shells. Nothing else in the dredge, which had evidently passed over fine sand.

Station 63.—1·2 mi. N.W. of No. 1 Blackwater Buoy. Towing S.S.W. ¼ S. 0·4 mi. *ca.*, 8 fath.

1 dredge, ... } Oysters, 18.
1 large dredge, ...

The dredges full of stones and old oyster shells encrusted with white worm tubes (*Serpula*). A few starfish, sun-stars, and whelks. Three other dredges shot here were lost.

Station 69.—1·6 mi. W.N.W. ½ N. of No. 2 Blackwater Buoy. Towing N.W. ¾ N. 1·5 mi., 9½ to 9¼ fath.

1 large dredge, ... Oysters, 12.

Stones encrusted with white worm tubes, gravel, broken shells, and an immense quantity of old oyster shells. Several whelks, one borer, several starfish, one sun-star. The oysters more or less encrusted with white worm tubes; some slightly encrusted with mums.

Station 70.—6 mi. N.N.W. ½ W. of Blackwater No. 3 Buoy Towing N.W. ½ N. 1·9 mi., 10 to 8 fath.

Small otter trawl (very light ground rope), Oysters, 9.

The ground fine at commencement, but rough towards end of haul. A few starfish, one sun-star, and two lumps of mums; one constructed of very coarse sand.

Station 68.—2·4 mi. S.E. ¼ S. of Tinnaberna. Towing S.W. 1·1 mi., 9 to 10 fath.

A large dredge, capsized, but with lacing open, so that it would have picked up some stones and shells had any been there. It appeared to have encountered only sand.

The Shell, Shells, or Shelly bed, as I have heard it variously called, was located by our pilot between the southern end of the Rusk and the northern end of the Blackwater Bank, but nearest to the latter.

We had not an opportunity of trying it at slack water. At other times the tide is so strong that the ground cannot be properly worked by a big vessel like the "Helga," as the ground is exceedingly rough and foul. There is smooth ground, fit for trawling, between the Shell and the Ballyvaldon beds, and, apparently, as will be seen from Station 70, a smoother part of the Shell bed extends to the edge of this.

We found some young oysters, and though we could not properly explore the bed, I think it not at all improbable that a sailing dredger might find a fair quantity of oysters in parts of it, but she would be a good deal troubled by hitches. The oysters, however, on the main part of the bed are very much encrusted with white worm tubes, which add greatly to their weight, and are practically impossible to remove.

SECTION 9.

BALLYVALDON BED.

Station 39.—0·4 mi. E.S.E. ½ E. of Norris Castle. Towing S.W. by W. 0·6 mi., 5½ fath.

3 dredges, ... } Oysters, 73.
1 large dredge, ... }

Stones and fine gravel. Starfish and sun-stars fairly plentiful; several almond whelks; white worm tubes plentiful on oyster shells; a small quantity of mums, but no "clods."

Station 38.—1·05 mi. N.W. ½ W. of No. 2 Rusk Buoy. Towing S.E. ½ E. 5 mi., 7 fath.

4 dredges, ... Oysters, 148.

Many starfish; sun-stars fairly plentiful; a few whelks and almond whelks; white worm tubes common on oysters; mums not plentiful, and not seriously encrusting oysters.

Station 40.—0·9 mi. E. by S. ½ S. of Tinnaberna. Towing N.N.E. ¾ E. 2·1 mi., 7 fath.

3 dredges, ... Oysters, 78.

Much the same as last; the starfish much more plentiful at the end than at the beginning of the haul.

Station 53.—1 mi. E. by S. ½ S. of Norris Castle, 7 fath.

A large dredge was shot, but hardly moved, owing to foul wind and tide; when hauled it contained two oysters.

Station 56.—1·3 mi. E.S.E. ½ S. of Norris Castle. Towing W. ¾ S. 0·8 mi., 7 fath.

2 dredges, ... Oysters, 33.

Working across the tide, dredges not fishing well.
Stones and shells. Starfish fairly plentiful; several sun-stars; a few beard mussels. The oysters cleaner than in preceding hauls.

Station 61.—1 7 mi. E. of Tinnaberna. Towing 0·5 mi. N. E. by N., 7 fath.

2 dredges, ... } Oysters, 30.
1 large dredge, ... }

Tide too slack to bring dredges along well. Stones, several starfish, a few sun-stars, and beard mussels. The oysters fine in shell.

Station 60.—1·1 mi. S.E. by E. of Ballyvaldon Gap Towing N.E. by E. 4 mi., 8 to 7 fath.

3 dredges, ... } Oysters, 333.
1 large dredge, ... }

Stones, especially towards the end of haul, which went too near the Rusk Bank. Many oyster shells, mostly in first half of haul. Starfish fairly plentiful in first half, numerous in second half; sun-stars fairly plentiful; a few whelks; white worm tubes common on old shells, and some on living oysters. A few lumps of mums in second half of haul.

I have included in the name Ballyvaldon bed the whole stretch of ground, about 5½ miles long by 1½ mile wide, which follows the coast from Ballyvaldon Gap towards the Sluices, though parts of this area appear at times to have been known by other names. It is by far the best stocked bed on the coast, and may, I think, be considered in a satisfactory condition, since the catch comprised oysters of all ages. Indeed it seems not improbable that this bed has acted as the distributing centre of spat to other grounds to the north, where we found no evidence of oysters in sufficient number to maintain the stock. To the south of the Gap there is a long stretch of sandy ground, and, as far as I can gather, there never were any important beds in that direction, save about Wexford Harbour, which still yields some return to the local boats. The number of oysters which we dredged may not appear large, but are greatly in excess of what we encountered on any other bed, while the continuously productive area is also much larger. I was given to understand that the Ballyvaldon oysters were smaller, with more fish to shell than those of the northern beds, but I could not see that this was the case. "Clods" are certainly conspicuous by their absence, and comparatively few of the shells have any serious weight of white worm tubes on them; but in addition to the "fern" (*Sertularia abietina*), which is not disfiguring, there are a good many soft worm tubes (*Terebella*, or the like), sea-squirts (*Ciona intestinalis*), and small shell-fish (*Crenella discors*) to be cleaned off. Dredging might improve the condition, giving a smaller, deeper shell, but on the other hand it is at least not improbable that the bed owes its present stock to its remoteness from fishing centres, and consequent freedom from human molestation.

A fair idea of the sizes of oysters now present on the bed is obtainable from the following list, being the summary of several hauls made in April:—

Number.	Size in inches.	Condition of shell.
3	2	thin.
2	2	thick.
14	$2\frac{1}{2}$	thin.
16	$2\frac{1}{2}$	thick.
15	3	thin.
22	3	thick.
21	$3\frac{1}{2}$	thin.
107	$3\frac{1}{2}$	thick.
6	4	thin.
105	4	thick.
1	5	thin.
2	5	thick.

The sizes were taken by gauges, the oyster being held at the hinge and passed through the gauge. An oyster passing through a $3\frac{1}{2}$ in. gauge, but sticking in a 3 in. gauge, is counted as measuring 3 inches, and so on. The condition "thin" implies a very thin flat shell, containing, in sizes below $3\frac{1}{2}$ inches, only a very small fish. In the larger sizes it becomes a matter of some difficulty to draw the line of demarcation. The shells here classed as "thick" are all fairly well fished, but there is great variation in the weight of shell. Comparatively few were found seriously sponged on this ground.

A Wexford boat, dredging this bed last year, is reported to have taken 700 oysters in four hours, which is the only indication which I possess of the relative efficiency of a professional dredger and the "Helga." The best haul made by the latter took 166 oysters in forty minutes, but most hauls gave about 100, or less, per hour.

Inside the ground which we worked I am informed that there once existed a bed in very shoal water, where the oysters were of a smaller class, more like what are known as "natives" than their fellows from the deeper grounds. Whether this bed still exists I had no means of determining, as the "Helga" draws too much water to permit of our making search.

Section 10.

PRUSSIA BEDS.

I made hauls at the places indicated as the sites of the Prussia beds, viz.:—

2·9 mi. E.N.E. $\frac{1}{4}$ N. of Greenore Point (Wexford). Towing N.N.E. 1 mi., 16 fath.

and

3·8 mi. E. by S. $\frac{1}{2}$ S. of Rosslare Point. Towing N.E. 2·1 mi., $12\frac{1}{2}$ to $12\frac{1}{4}$ fath.

These hauls yielded stones, muddy sand, and several oyster shells,

old, worn, and blackened hy mud. Also some whelks, much larger than the average further north, and other animals of no importance in this connection.

As these beds are very remote from Arklow and Courtown, and never seem to have been of much importance, I did not explore the neighbourhood further.

I have made no attempt to examine the home beds which still supply the Wexford fishermen with a small harvest.

OFFSHORE GROUNDS.

On the chart marked at Arklow for our guidance are shown three spots, lettered A, B, and C, as to which is written, "the fishing" "boats during summer season, when herrings were plentiful, have" "had their nets sunk to the bottom by weight of fish, and oysters" "of small shell, dark in colour, full of fish like 'Red Banks' and of" "fine quality, have been found in the nets when hauled."

A is about four miles E. of the South Arklow Light, about 34 fathoms. In a circular area of 6 miles diameter, of which A is the centre, we made six hauls, covering about 9½ miles, and got, in two hauls, a few shells, but no oysters in any. Several hauls recently made by Mr. Farran in this locality gave no indication of the presence of oysters.

B is about 7¼ miles S. by E. ¼ E. of the South Arklow Light, about 34 fathoms. We made four hauls, covering six miles, within a circular area four miles in diameter, of which B is the centre. One oyster was taken near the point B, and five in the most seaward haul, logged by Captain Macauley as 10·1 miles E. of the Blackwater Light, towing N.E. ½ N. 1·9 miles. Some oyster shells and many starfish were also taken in this haul. On other parts of the ground there were a good many shells of horse-mussels.

The oysters were small, old, thick-shelled, and of no commercial value.

The ground will be explored further to seaward when opportunity offers, but work here, when the weather is suitable for dredging, is apt to be much interrupted by haze.

C is about 9 miles W.S.W. of the Blackwater Light, about 36 fathoms. We made eight hauls, covering 11¼ miles, in the neighbourhood, over an area extending 4½ miles inshore, 2 miles off shore, and 5 miles to the southward (the ground covered by the hauls about B is immediately to the northward).

In the most easterly haul we got one small old oyster. A few old shells occurred in most of the hauls, and the oyster "fern" (*Sertularia abietina*) was of pretty frequent occurrence; but although this hydroid appears to be only abundant, on the inshore beds, where oysters are also plentiful, this may be due rather to the exceptional facilities which a clean living oyster offers for its lodgment inshore than to any community of interest.* Mums are rather plentiful over this area, and in one haul scallops were

* The Hydroids, of which the oyster fern is one, though plant-like in appearance, are really colonial animals, feeding like the oyster on very minute organisms, and it may be that the constant association of the fern with the oyster is due to a similarity in food.

encountered. There were also a good many shells of horse-mussels, besides other animals of no special interest.

At a spot marked D on the chart it is stated that oysters of large size were got by the "Favourite" of Arklow. The place is about 10 miles E. by S. of the Lucifer Light, 43 or 44 fathoms. Three hauls, covering 5 miles, were made in an area of about 4 square miles around it, but oysters were only represented by one shell.

We made several hauls between the areas I have mentioned above and the banks, but found nothing of interest. It will, I think, be allowed that there is very little indication of the existence of oysters in paying quantity and of marketable quality on the off-shore grounds, and even if our subsequent explorations further seaward reveal the presence of oysters in some number, I do not think it will be of much importance to fishermen unless they prove to be distributed in reasonable quantity over large areas. That oysters may be found here and there, even in bulk on isolated tracts, is not unlikely, since much of the bottom is suitable for the settlement of spat, which, by the combined influence of tide and wind-drift, might be carried many miles from the parent bed. The soundings, however, of this part of the sea-floor are so even and haze is so frequent in weather suited for dredging, that small beds, though well stocked, could not often be found. Moreover, it has yet to be shown that these deep off-shore grounds are capable of producing oysters of better quality than the few stunted specimens which we encountered.

Appendix, No. III.

THE BRITISH AND IRISH GOBIES.

BY

E. W. L. Holt and L. W. Byrne.

Plates I. and II.

The British and Irish Gobies form a group of fishes too small to be of direct value for food purposes, since the largest of them only exceptionally exceeds a length of five inches; but they are not inedible, and kindred species are regarded on the southern coasts of France with considerable interest from the point of view of the table, while affording a mild form of sport to the enthusiastic sea-angler.

We are concerned, however, chiefly with their rôle in the general marine cosmos, little as we may at present understand it, since it is certain that forms so numerous in individuals, living in association with fish and crustaceans ofmarket value, cannot but exercise an influence direct or indirect upon their neighbours, whether as food, as enemies, or merely as competitors for the available food supply.

Absolute promiscuity of distribution and habit is a condition unknown to nature, and the closer the bionomical study the clearer does it appear that each organism has its own defined sphere of influence. Such study, however, is impracticable when it is not possible for the student to determine the identity of the forms under observation; and, in the case of the Gobies, it will be generally agreed that existing literature, of a readily accessible nature, gives no satisfactory assistance.

It is in the hope of removing this difficulty that we put forward the present notes and drawings. We believe that they will enable others, who may not have had the same opportunities of comparing the different species, to readily recognise any which come under their observation; and so to augment, without uncertainty of determination, our very imperfect knowledge of the habit and environment of the various forms. As Smitt remarks, it is the giants and pygmies among vertebrates that give the systematist most trouble. Some of our Gobies are among the smallest of known fishes, and, as will appear later, their proper definition demands a wealth of illustration apparently, but, as we think, not really out of proportion to their importance.

Our studies of the anatomy of the *Gobiidæ* have not been carried to a point that will permit us to deal, usefully, at any length with the systematic position of the family. Dr. Günther, in his "Introduction to the Study of Fishes" (1880), placed the *Gobiidæ* (including therein *Callionymus*) and the *Discoboli* (*Cyclopterus* and *Liparis*) in a division termed by him *Gobiiformes*, which appears to have been, as constituted, impossible to accurately define. Jordan and Evermann ("Fishes of North and Middle America," 1898), following Gill and Garman, relegated the *Discoboli* to what appears on anatomical grounds to be their true position near the *Cottidæ*, and

reconstructed the group *Gobioidea* from Günther's *Gobiidæ*, placing in it two families, the *Callionymidæ* and *Gobiidæ*, but without finding any satisfactory definition of the group. As Cunningham suggested some years ago (Journ, M. B. Assoc., N.S., vol. I., p. 37) and as Boulenger has recently demonstrated (Ann. Mag. Nat. Hist., ser. 7, viii., 261 [1901]), the *Callionymidæ* are in fact most nearly related to the Trachinid Acanthopterygians, and must also be moved from the position previously assigned to them near the *Gobiidæ*. Through the kindness of Mr. Boulenger we have been enabled to examine the skeletons of several members of the *Gobiidæ*; and these do not seem to indicate any close relationship either with the *Callionymidæ* or the *Discoboli*, but point rather to a position near the Perciform Acanthopterygians. From these they may readily be distinguished by the form of the pectoral girdle in which the scapula and coracoid are much reduced, and the pterygials large and four in number; in the British *G. niger* and in *G. capito*, which we have dissected, the pterygials were almost completely fused into a semi-circular plate which supported the pectoral fin-rays.

In view of these characters there seems to us no good reason for disturbing Günther's group *Gobiiformes*, as limited by the exclusion of the *Callionymidæ* and *Discoboli*; and, without in any way attempting either to accurately define the characters of the group or to forestall the result of Mr. Boulenger's researches into the anatomy of the Teleostei, the position of the *Gobiidæ* may be provisionally indicated as follows:—

Order, ...	**TELEOSTEI.**
Sub-order, . . .	ACANTHOPTERYGII.
Group, ...	GOBIIFORMES.
Family, ...	GOBIIDÆ.
British and Irish species,	*Gobius niger* L.
	paganellus. Gm. L.
	Friesii. Collett.
	Ruthensparri. Euphras.
	minutus. L.
	pictus. Malm.
	Jeffreysii. Gtbr.
	orca. Collett.
	scorpioides. Collett.
	Aphia pellucida. Nardo.
	Crystallogobius Nilssoni. Düb. and Kor.

These notes are confined to the species of *Gobius* occurring in our waters, as the excellent account of *A. pellucida* and *C. Nilssoni* given by Collett,* cannot be amplified in any material respect from our observations on those species.

We have counted the numbers of vertebræ in the following species:—

	Precaudal.		Caudal.		
G. niger (2 specimens), .	12	+	15-16	=	27-28
G. paganellus (4), . .	12	+	15-17	=	28-29
G. Ruthensparri (2), . .	12-13	+	18-19	=	31
G. minutus (6), . . .	12-13	+	18-20	=	30-32
G. pictus (3), . . .	11-12	+	16-17	=	28

* P.Z.S., 1878, p. 318; for a short note on the breeding season and ova of *A. pellucida*, see M. B. A. Journal, V., p. 338 (1898).

The members of the genus *Gobius* found in the British area, are fishes of stout or slender habit, and subfusiform or subcylindrical form, with more or less depressed heads, and sometimes slightly compressed bodies. The head is large, rounded, and usually blunt in front, and is contained $3\frac{1}{2}$ to 5 times in the total length (excluding the caudal fin, as throughout in this paper). The eyes are comparatively large, situate high up, and close together, and never separated by an interval exceeding their horizontal diameter; frequently they almost touch. The snout, as a rule, is not very much longer or shorter than the horizontal diameter of the eye. The scales are irregularly arranged, and are far larger posteriorly than anteriorly; those of the lateral line are not differentiated. There are sometimes well-marked lines of dermal papillæ on the head and operculum. The spinous dorsal consists of VI. or VII. (rarely V. or VIII.) rays, and almost reaches to or is only separated by a very short interval from the soft dorsal, which is opposite and similar in form to the anal; the pectoral is of moderate size and rounded, its upper rays sometimes separate and silk-like; the ventrals, each of which has one spinous and five soft rays, lie together in the mid-ventral line, and form a single fan-like fin, which functions as a sucker, and may or may not have its anterior walls united by a basal membrane. There is a large and conspicuous urogenital papilla.

The colours of the body are usually darkest on the head and forepart of the body, and in the region of the lateral line, which is not infrequently marked by a series of more or less well-defined blotches or spots; the smaller species frequently possess several paler saddle-shaped patches along the back, and traces of similar markings may be observable in examples of some of the larger species.

As genera are at present understood among fishes, the genus *Gobius* is too large and loosely defined to be either "natural" or convenient; no satisfactory attempt has yet been made to sub-divide it, and it would be useless to found any such attempt upon the British and Irish members of the genus alone, but it seems worth while to point out the five well-marked groups into which these members fall:—

1. Gobies of comparatively large size, stout habit, and sub-cylindrical form, with the upper rays of the pectorals silk-like, and with moderately developed lines of dermal papillæ on the head and the operculum. *G. niger* and *G. paganellus.*

2. Gobies of moderate size, moderately stout habit, and somewhat compressed form, with no silk-like rays, but well-marked rows of dermal papillæ. *G. Friesii.*

3. Small gobies of somewhat compressed form, and moderately slender habit, adapted for living among weeds and not on the bottom. *G. Ruthensparri.*

4. Gobies of moderate or small size, slender or moderately stout habit, and sub-cylindrical form, adapted for living at the bottom. *G. minutus*, *G. pictus*, and *G. Jeffreysii.*

5. Very small gobies, without an anterior membrane to the ventral fins (the genus *Lebetus* of Winther). *G. scorpioides* and *G. orca.*

In the case of fishes of such small size, the ready identification of the various species, especially in their younger stages, is a matter

of some difficulty. The irregular arrangement and variation in size of the scales makes it difficult to count them with uniformity and accuracy; the number of fin-rays is frequently not diagnostic; measurements are so small that a difference between two observers in the method of taking them (however small in itself) may cause considerable discrepancies in tables of proportions founded upon them, and make them unreliable.*

Although it is never safe to rely upon colours alone to distinguish species, the form and colouration of the spinous dorsal fin appear in most cases to provide the readiest method of "spotting" gobies, but should only be used in conjunction with and carefully checked by other methods.

A matter which ought always to be regarded in dealing with these fishes—but which has never (in systematic literature) received the attention it deserves—is the great difference between the sexes, more especially at the breeding season, and between adult and immature males. The following characters appear to be sexual, and must be borne in mind in identifying the species to which an example belongs:—

(1.) The urogenital papilla of the male is long and pointed, of the female short and blunt.

(2.) The colours of the male (more especially those of the dorsal fins) are more brilliant than those of the female; the throat, ventrals, and anal fin are often darkly pigmented in the male, while pale in the female.

(3.) The posterior rays of the soft dorsal and anal are often comparatively longer in the male than in the female; and sometimes a few rays of the spinous dorsal are prolonged in the male.†

(4.) The head of the male may be heavier and blunter, the habit somewhat stouter, and the caudal peduncle comparatively deeper than in the female.

Some only of these characters are found in most species; they are, as a rule, more marked in the breeding season, and appear to vary considerably in the extent to which they are developed in different individuals. Young examples of either sex cannot be distinguished by conspicuous external differences, and in some species the male may be sexually mature before the secondary characters are fully developed.

The intenser colours of the male may be to some extent lost and again assumed almost instantaneously under the influence of any excitement, and the iridescent colours of the dorsal fins and sides of some of the smaller species are equally evanescent.

In habits all of our gobies have much in common. All are more or less gregarious, and (with the exception of *G. paganellus*, whose habitat rather prevents it) all of them appear ordinarily to live in larger or smaller assemblages; and even in the breeding season the gregarious habit is not entirely lost. *G. Ruthensparri*, which seems to move in shoals (as contrasted with the mere "gregariousness," and local abundance of other species), swims among weed at some distance from the bottom, but with this exception all of them live on the bottom, hiding under stones or shells, or lying flat upon or

* The measurements given at the end of this paper were made by Mr. Byrne.

† It is probable that these differences obtain in all species, but in some they are so slight as to be quite inconspicuous.

partly buried in mud or sand. Their food mainly consists of crustaceans, worms, and other marine invertebrates. The ova are demersal and are laid in closely-set masses in some sheltered spot, each individual ovum heing attached by its hase to the ohject upon which they are laid; in shape they are roughly circular, pear-shaped or fusiform, contain no single, well-defined oil-globule,* and are attached by a basal network of hyaline strands radiating from the micropylar region; in comparison to the size of the fish they are very large. The larva emerges in an advanced condition with the mouth already open and still retaining the larval fin-fold, hut very rapidly attains the form of the adult.

As the hreeding season approaches, each male appears to select a suitahle site for the deposition of eggs, and to expend more or less trouble in rendering it suitahle for that purpose; after the completion of this task he remains constantly in the neighhourhood, endeavouring to attract the attention of any female who passes, and fighting (with more or less serious results) with any other male who endeavours to come near him. Having secured a female, he mounts guard during the deposition of the ova, and after they have heen deposited, remains in the "nest," guarding them until they hatch, circulating the water ahout them with his fins. The female after depositing her ova departs, and takes no further interest in her offspring, but after a decent interval (of ahout a week in *G. minutus*) proceeds to perform a similar service for another male; while the dutiful father, so soon as he is relieved of the cares of one family, begins to look for a fresh female, who will enahle him to burden himself with another.

Collett has, many years since, shown that the allied *Aphia* and *Crystallogobius* are truly "annual" vertehrates, and it is very possihle that the lives of many gohies are no longer; we have no detailed ohservations upon this point to record, hut some remarks upon the subject will he made when treating of the individual species.

So far as geographical distrihution is concerned all our gohies appear to be normal members of the fauna of the N.E. Atlantic; the majority of them are found in Scandinavian waters, and a few extend into the Mediterranean. *G. paganellus* has the most southerly distrihution, and does not reach the north of our area. Many of them are so little known and so consistently overlooked that no remarks on their distrihution can have much value.

In the following descriptions the terms and ahhreviations used are, as a rule, those employed in the British Museum Catalogue. References to literature since the date of Day's British and Irish Fishes only are given for species recorded as British in that work.†

We take this opportunity of expressing our indehtedness to Mr. Boulenger, of the British Museum, who has most kindly allowed us to figure a specimen in the collection under his charge, while assisting us in many other ways; to the late Mr. M. F. Woodward, Mr. J. E. S. Moore, and Miss A. J. Holt for help in making the original sketches upon which several of our figures are hased; to Mr. G. P. Farran, for several observations on the habits of different species; and to Miss G. M. Woodward, whose figures sufficiently show the help she has rendered us, without any added comment on our part.

* A large number of minute globules are present in the yolk matter.

† References to "Smitt" are to Smitt's History of Scandinavian Fishes.

We may add our regret that the exigencies of the process employed make it impossible for us to reproduce in colour the most beautiful and life-like picture of *G. Ruthensparri*, by the late Mr. M. F. Woodward, upon which Miss Woodward's figure is based.

Our observations were commenced at the Laboratory of the Marine Biological Association, to whom we desire to express our obligations.

KEY TO THE SPECIES.

The following table may assist in the identification of the British and Irish species:—

A. Ventrals with anterior membrane.

1. Superior rays of pectoral, separate and silk-like.
   (*a.*) Not more than 42 scales in a longitudinal series; middle rays of spinous dorsal longest. *G. niger.*
   (*b.*) 50 or more scales in a longitudinal series; spinous dorsal with a superior pale horizontal band. *G. paganellus.*

2. Pectoral without separate or silk-like rays.
   (*a.*) Conspicuous rows of dermal papillæ on head and operculum; about 29 scales in a longitudinal series. *G. Friesii.*
   (*b.*) No papillæ on operculum.
      i. Interorbital space $\frac{3}{4}$ or more of snout, spinous dorsal with vii. (or viii.) rays, a conspicuous black spot at origin of caudal fin. *G. Ruthensparri.*
      ii. Interorbital space less than half of snout; spinous dorsal with vi. (rarely vii.) rays.
         a. Muzzle blunt, 34 or more scales in a longitudinal series.
            (1.) 34-41 scales in a longitudinal series, rows of black spots on dorsal fins; not attaining a length of more than $2\frac{1}{4}$ inches. *G. pictus.*
            (2.) Rarely less than 40 scales in a longitudinal series (usually many more); not more than one (or two) large dark spots at posterior end of spinous dorsal; attaining a length of at least $3\frac{1}{4}$ inches. *G. minutus.*
         b. Muzzle somewhat pointed; scales large, 25-30 in a longitudinal series. *G. Jeffreysii.*

B. Anterior membrane of ventrals wanting or vestigial. (*Lebetus*).

1. Habit slender; soft dorsal with a black band superiorly; no pale band on caudal peduncle. *G. orca.*
2. Habit stout; soft dorsal banded with red; a broad pale band on caudal peduncle. *G. scorpioides.*

GOBIUS NIGER, L.

BIG GOBY, BLACK GOBY.

Fig. 1.

G. niger.—Day, I., p. 163 (1884); *Petersen*, Fiskeri-Beretning Kbhvn., 1891, p. 244, Pl. v., Fig. 5; *Smitt*, I., p. 245.

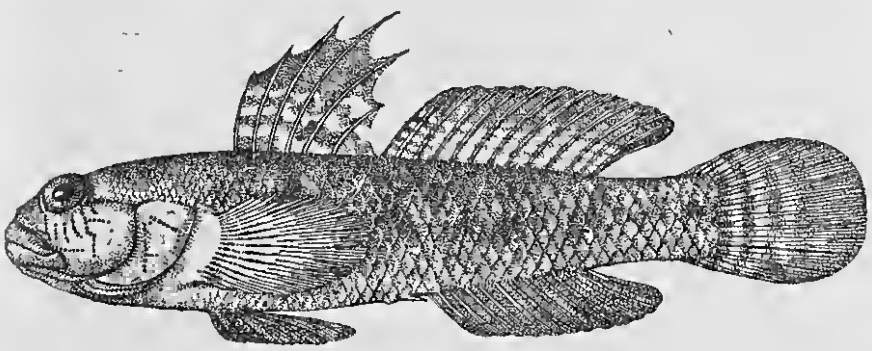


Fig. 1. *G. niger* ♂ × $\frac{4}{5}$.

D. VI., 12-14; A. 11-13; Sc. 36-40, tr. 13-15. Habit, stout; form, subcylindrical; depth of body, 5 to $6\frac{1}{2}$ times in total length; length of head, about 4 times; eye, 3 to 4 times; snout, $3\frac{1}{2}$ to 5 times in length of head; interorbital space, narrow; scales, larger posteriorly than anteriorly; minute, and almost embedded in the skin on the head and front part of back. Conspicuous rows of dermal papillæ on the head and gill-cover. Pectoral fin, having the branched extremities of the first two or three upper rays produced into short silk-like filaments, not usually exceeding five in number, and not reaching the level of the dorsum. Central rays of the spinous dorsal longer than the rest; their extremities markedly depressed, giving a characteristic form to the fin.

Ground colour of the body of any shade from pale ochreous yellow to brownish or blackish grey, diversified by several large dark brown or blackish patches extending obliquely forward across the sides when distinct in outline, but often so obscure as to merely impart a darker cloudiness to the colouration. The sides are never distinctly banded, the lighter and darker areas being profusely speckled and marbled with darker and lighter markings. Nape and top of head usually rather pale; sides of head dark, with lighter markings, but without rounded or oval pale spots.

Pectoral fins, with rather inconspicuous yellow and brown markings, indistinct on distal parts. Spinous dorsal grey or yellowish, with a few rather broad, irregular, reddish-madder bands and some darker markings, but without a pale border.

Soft dorsal grey or yellowish with numerous indistinct madder spots, which are arranged in the form of inverted chevrons about the fin rays, and do not form oblique bands.* There is no pale marginal

* Our figure is taken from a specimen preserved in formaline, and therefore does not show the chevron markings. The division of the lower part of the fin into alternate horizontal bands of darker and lighter tone is largely a *post-mortem* effect, due to the disappearance of the coloured chromatophores.

band. Both spinous and soft dorsal may have a dark spot at the anterior upper edge. Caudal marked in much the same way as soft dorsal.

Isthmus, ventrals, and anal grey or dark grey in the male, little or not at all pigmented in the female.

The above description presents what appears to be the most usual colouration of the species, but it is subject to considerable variation, and often the general effect approaches an uniform blackish brown. Some specimens which we took on the zostera beds in the Helford River, Cornwall, were smoky black, with hardly a trace of brown.

Total length, 122 mm. (5 inches).

The male appears to be slightly darker than the female, but there is no material difference, and our friend Mr. G. P. Farran, who has kept breeding members of both sexes under observation, informs us that no special livery is assumed by the male during the breeding season. In addition to the greater comparative length of the posterior rays of the soft dorsal and anal, the adult male is marked by the prolongation of the third and fourth rays of the spinous dorsal, which are longer than in the female, and may be produced into filamentous processes of considerable length. It is possible that this condition is of a temporary character and only manifest in the breeding season, but beyond that it is variable in males of the same size, we are not in a position to make a positive statement.

The presence of silk-like rays in the pectorals and the large size of the scales, render the recognition of this species sufficiently easy; the form of the spinous dorsal appears also to be diagnostic. The accounts sometimes given of this species seem, nevertheless, to show that it has been more or less confused with *G. paganellus*; and the English title of "rock-goby," sometimes applied to it, does not appear to be a particularly happy one.

Our observations of the habitat of this species lead us to conclusions somewhat different from those of Couch, who regarded it as essentially a rock-haunting fish, and named it the rock-goby on that account. He records that his largest specimens, up to 9½ inches in length, were always found in rock pools above the reach of ordinary tides, and often containing practically fresh water, whereas those which keep to the open shore were smaller and usually found in oozy places. We have never found specimens of more than about 5 inches in length on British and Irish coasts, nor any at all in rock-pools, and the species is common in Denmark, where, as Dr. Petersen informs us, there are no rocks. It seems possible, as suggested by Boulenger (Ann. Mag. Nat. Hist., Ser. 7, iv., p. 229 [1899]), that these large rock-gobies may have been specimens of *G. capito*; though, as Couch found no difficulty in distinguishing *G. paganellus* from *G. niger* it seems strange that he should have confused the latter with *G. capito*, which much more closely resembles the former species.

Couch explained the large size of his specimens by the circumstances of their environment—freedom from larger enemies and abundance of food. Such pools are often very richly stocked with dwarf prawns, of the species (or variety?) described as *Palæmon Leachii*, and we do not consider the explanation as unreasonable.

We regard *G. niger* as the estuarine representative of the larger British and Irish Gobies, since it seems most abundant in estuaries and bays having a certain taint of fresh water. In such places we have found it abundant on comparatively clean, muddy, or sandy ground from above low water mark to a depth of a few fathoms,

wherever there are sufficient small stones, shells, and other debris to afford it shelter and suitable breeding sites. On a beach of muddy gravel, strewn with boulders, at Ballynakill, we have taken it in company with *G. paganellus*, the diverse character of the shore being apparently suitable to both species.

The ova are deposited in the spring in any suitable shelter, and are watched over by the male during incubation; they are regularly fusiform in shape, with a blunt or rounded apex, and measure about 1·5 mm. in height; the rounded apex (cf. Petersen, *loc. et fig. cit.*) serves to distinguish them from those of *G. paganellus*, which are the only known British or Irish goby's ova they at all resemble.

G. niger occurs upon all our coasts and upon those of Western Europe, from Norway to the Bay of Biscay; authors differ as to whether it occurs in the Mediterranean or not, but some gobies sent to us by Dr. Kyle from Naples, do not appear to be in any way distinguishable from the typical *G. niger*.

GOBIUS PAGANELLUS, Gm. L.

Rock Goby.

Pl. I, Fig. 2 (♂), 1 (♀).

G. paganellus.—Day, I., p. 162; *Holt and Byrne*, Jour. M.B.A., V., p. 335 (1898).

D. VI. (V.), 13-15; A. 11-13; Sc. 52-58, tr. 17-22. Habit, stout; form, sub-cylindrical; depth of body, 5 to 5¾ times; length of head, about 4 times in total length; eye, 3 to 3 4-5th times; snout, 4 to 5 times in length of head; interorbital space, narrow; scales, larger posteriorly, minute, and almost buried in the skin on the head and forepart of the back. Rows of dermal papillæ on the head and operculum, generally similarly arranged to those in *G. niger*, but less conspicuous; 4 or 5 upper rays of pectoral, with silk-like filaments, which are much more numerous than in *G. niger*.

Colour, greyish or yellowish brown, varying much in tone in different individuals, marbled with darker shades of brown; colour generally darkest on the head and in the region of the lateral line, which is usually marked by a series of irregular dark patches. The dorsal fins are similar in colour to the body, with dark, usually reddish, oblique bands; along the top of the spinous dorsal runs a well-marked horizontal band of yellow or buff colour, sometimes almost white.*

The breeding male is deep purplish madder all over the head and body, becoming almost black anteriorly, and has the band along the top of the first dorsal orange or bright buff. This colour phase is gradually assumed, darker patches, especially on the fins, manifesting themselves at a period considerably antecedent to the breeding season, but the normal phase can be resumed at any moment.

Total length, 120 mm. (4¾ inches).

* Except in the case of breeding males, it is not easy to express the difference in colouration which exists between *G. paganellus* and *G. niger*. The former, however, never assumes an uniform blackish brown or smoky black colour, and the transverse banding or marbling is more marked than in *G. niger*, even in very dark specimens. The pale areas on the gill cover usually assume a rounded or oval form, while the madder markings on the dorsal fins tend to arrange themselves in the form of *obliquc* vermicular bands.

The hand along the top of the spinous dorsal, which is well marked from a length of less than an inch upwards, usually renders the immediate identification of this species easy; in any case the presence of numerous silk-like rays to the pectorals, combined with the number of scales and the normal form of the ventrals, is absolutely diagnostic.

G. paganellus is, in our fauna, the rock gohy *par excellence*; it is usually abundant among rock-pools and under stones between tide-marks and on rough or rocky ground in shallow water, but seems never to be found in water of any considerable depth, and only exceptionally on smooth ground. This is a more southerly species in its distribution than *G. niger*; it is found at Madeira and in the Mediterranean, and appears to be common in all suitable localities on our coasts, as far north as the Firths of Forth and Clyde, and the North of Ireland; it has not been found North of the British Isles.

Breeding takes place in the spring (in Ireland and Devonshire about Easter), and the ova are most commonly laid on the underside of an overhanging rock or stone, and there guarded by the male until they hatch; probably any suitable shelter, such as a shell or old tin, is used for breeding purposes, but the underside of a stone appears to be the usual site.

The ova are regularly fusiform in shape, about twice as high as wide, and pointed at the apex; specimens measured were from 1·84 to 1·9 mm. high. They may be distinguished from those of all our other gobies (except *G. Friesii*, the ova of which are unknown) by their size and shape, as they are always more or less acutely pointed at the apex, those of *G. niger*, which resemble them in size, being blunt and rounded.

The following species, though not as yet recorded, may occur in British or Irish waters:—

Gobius capito, C. and V.

G. capito Moreau Poissons de la France, II., p. 203, Fig. 102 (1881); *Holt*, Ann. Mus. Marseille, v. p. 43 (1899); *Boulenger*, Ann. Mag. Nat. Hist., Ser. 7, iv., p. 229 (1899).

D. VI. 14-15; A. 11-13; Sc. 60-62, tr. 18-20.

Habit, stout and heavy; depth of body, 5 to 6 times in total length; length of head, $3\frac{2}{3}$ to $4\frac{1}{4}$; eye, 5-$6\frac{1}{2}$ times in head; snout, $3\frac{1}{2}$-$4\frac{1}{2}$; interorbital space slightly less than diameter of eye.

Pectoral with upper rays silk-like; *ventrals with well-developed anterior membrane which forms an obtusely pointed lobe on either side.*

Attains a length of 10 inches or more.

Our information as to changes of colouration in the breeding male is of a negative character. These gobies breed regularly in the tanks at the Maritime Laboratory of Endoûme, Marseilles, but during two seasons spent by one of us at the Laboratory, no change of colouration was observable in the males guarding the ova.

Apparently allied to *G. paganellus*, but a much larger species; it may be distinguished by the form of the ventrals, wide interorbital space, and number of scales.

This fish is common in the Mediterranean, and has lately been recorded by Boulenger from the Gulf of St. Malo; there is no record as yet of its occurrence on our coasts, unless Couch's large rock gobies are referable to it. In habits it appears to be intermediate

between *G. niger* and *G. paganellus*, and the ova resemble those of the latter species, but are much larger, measuring about 3·6 mm. by 1·23 mm.

GOBIUS FRIESII, Collett.

Fries' Goby.

Pl. I. Fig. 3.

G. Friesii Collett, Forh. Vid. Selsk. Christ., 1874, p. 154; *Holt and Calderwood*, Sci. Trans. Roy. Dub. Soc., Ser. 2, v. p. 417, Pl. xli., Fig. 3 (1895); *G. microlepis, Scharff*, Proc. Roy. Ir. Acad., Ser. 3, I., p. 458 (1891).

D. VI., 14-15; A. 13-15; Sc. 28-29, tr. 8-9. Habit, moderately stout; form, subfusiform and compressed (markedly compressed in comparison with the other British and Irish gobies); length of head, about 4 times, or somewhat less in total length; depth, about 5 times; eye, $2\frac{2}{3}$ to $3\frac{1}{3}$ in length of head; snout, about $\frac{2}{3}$ diameter of eye; interorbital space, very narrow; several well marked rows of dermal papillæ on head and operculum; scales large, extending as far forward as the eyes, decreasing somewhat in size anteriorly; spinous dorsal with some of its rays produced into filaments (this does not appear to be a sexual character, but we are unacquainted with the breeding male); pectoral fin, without silk-like rays; caudal fin, large and lanceolate in form.

Colour, pale grey; more or less tinged with brownish or yellowish green, especially on the dorsum. Rows of golden yellow blotches or spots on the back and sides, and on the unpaired fins. The filaments of the spinous dorsal rays sometimes black.*

Total length, 4 inches (100 mm.)

We are not aware of any sexual differences.

The compressed form, large scales extending far forwards, dermal papillæ on the head and operculum, and absence of silk-like rays from the pectorals, make the identification of this species sufficiently easy. Fries' Goby has not yet been recognised on the coasts of England or Scotland, but appears to be not uncommon locally in the West and South-west of Ireland, and must be abundant in the Irish sea on the soft muddy sand which extends from within a few miles of the coasts of Counties Louth and Down to the neighbourhood of the Isle of Man. Here it has been taken by one of us at depths between 15 and 30 fath., the deeper area having not as yet been properly explored. As many as six were caught on one occasion (22-20 fath., off Skerries Bay, 28/1/02) in a bag of mosquito mesh, with a mouth of about 2 ft. by 1 ft., attached to the back of a beam trawl†—a capture which seems to argue that the species was

* Specimens from about 20 fathoms are semi-translucent, and usually show hardly any colour except the yellow spots, but become darker by the *post-mortem* expansion of the darker chromatophores.

† A bag of fine material, having its mouth laced to the back of the trawl, about midway between the cod-end and the head-rope, appears to be the most reliable engine for the capture of small ground-fish and invertebrates, too small to be retained in a large-mesh trawl, and too active to be caught in a bottom-net of fine material hauled at a pace safe for such gear. The ground-rope of the trawl appears to sweep the small creatures upwards and to concentrate them about the centre of the back of the net, through the large meshes of which they easily pass. Apart from being more effective in capture this device has the merit of eliminating sand and other material from which delicate organisms are liable to injury in a net fished actually on the bottom. We believe the credit of its invention is due to Mr. W. S. Green.

very abundant on the ground fished over. Most of our specimens were obtained in January and February; and the same gear, with the addition of a much larger bag of sprat mesh, caught only two in July. Without further work it is only possible to suggest that the crop of adults dies off for the most part after spawning some time in the spring, since failure to touch small areas of particular local abundance would be an equally good explanation of the apparent relative scarcity of the species over the same general area in summer.

To the southward of the muddy area the bottom of the Irish sea is of firmer sand, and although this ground has been fairly well explored down to a depth of about 70 fathoms, it has not so far yielded any specimens of *G. Friesii*. The latter would therefore seem to have a predilection for muddy sand, and may perhaps be looked for with reasonable prospect of success on grounds known to be frequented by the white sole (*P. cynoglossus*), smeareen (*H. platessoides*), and the crustacean, *Nephrops norvegicus*, though it may not descend to the same depths as some or any of these.

Of its breeding season or habits we have no knowledge, but practically the only available objects for the attachment of its ova (if similar to those of other gobies) on the Irish Sea habitat are empty shells of *Fusus antiquus*, which here attains a very large size.

Fries' Goby was first added to the Irish list (under the name of *G. macroleps*) by Scharff, from an example recorded as taken at 5 fath. on the S.W. of Ireland, no other data being apparently available when it reached the Museum. Several specimens were taken by one of us in Killybegs outer harbour in June, 1890, in shallow water close to the shore, but no record was kept of the nature of the bottom. Specimens were also taken between 6 and 10 fathoms in Inver Bay, Co. Donegal, in the same month, other organisms recorded from the same haul appearing to indicate a sandy bottom. The record given by one of us in the same year from Cleggan Bay appears to have been erroneous, and may probably have been due to a confusion of the temporary labels of the two years of the Royal Dublin Society's Survey. Since 1899 we have made many attempts to find the species in Cleggan Bay and its neighbourhood, but without success.*

Outside Ireland *G. Friesii* is only known from three specimens, from the Strömstad and Gullmar Fjords in Sweden, and Christiania Fjord in Norway, all apparently from deepish water, as Smitt regards it as a deep-sea form. That it is by no means confined to even moderately deep water is sufficiently apparent from the evidence which we have adduced above, while beyond the Scandinavian records, which do not specify the exact soundings, we have as yet no knowledge of its existence much below the 30-fathom line.†

* On the 29th August, 1902, a single specimen was taken by Captain Macauley in Blacksod Bay, the depth recorded being 9 fath. The bottom here is generally sandy.

† Collett has suggested the possible identity of *G. Friesii* with *G. Lesueurii* Risso' a native of the Mediterranean shores of France and Italy. We do not know whether the types of that species are in existence, and have not access to any properly authenticated specimens. Neither Risso in his original description (Ichthyologie de Nice, 1810) nor Cuvier and Valenciennes make any mention of the dermal papillæ on the head and operculum which are so conspicuous in *G. Friesii*, with which their description in other respects substantially agrees, but these are stated to be present by Canestrini and Moreau. We can only say that Collett's suggestion appears to us to be well founded, but unless or until Risso's types are examined it is impossible to pronounce on the identity of the two species.

GOBIUS RUTHENSPARRI, Euphras.

Spotted Goby.

Fig. 2.

G. Ruthensparri.—Day, I., p. 160 (1884); *Petersen*, Fiskeri-Beretning Kbhvn, 1891, p. 251 (1892); *Guitel*, Arch. Zool., Exp. et. Gen. Ser. III., iii., p. 263 (1895). *G. flavescens.—Smitt*, I., p. 251 (1893); *M'Intosh and Masterman*, British Marine Food-Fishes, p. 172 (1897).

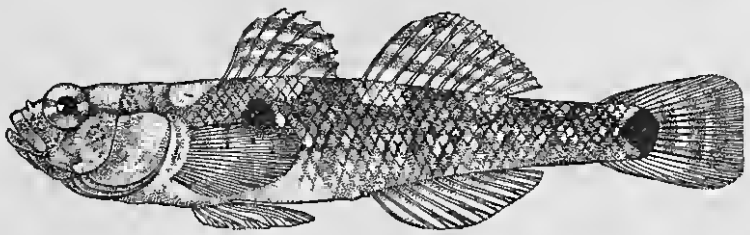


Fig. 2. *G. Ruthensparri* ♂ × 1⅓.

D. VII.-VIII., 10-11; A. 10-11; Sc. 35-40, tr. 12-15. Habit, slight; form, subfusiform, somewhat compressed laterally; depth of body, 5 to 6 times in total length; length of head, 4 to 5 times; eye, 3 to 3½ times in length of head; interorbital space wide, half or more of the diameter of the eye, and equal to or slightly less than the length of the snout.

The general body colour is yellowish or olive brown, sometimes almost green, or reddish brown of any shade from rich chestnut to pink. The ventral parts are yellowish white, even in mature males. Along the back is a series of about five or six saddle-like pale markings, more or less confluent dorsally. They vary much in distinctness during life, both in individuals and momentarily in the same individual, and often disappear after death. Along each side from the base of the pectoral fin to the root of the tail is a row of some seventeen (more or less) short transverse markings, which vary momentarily in colour from pale grey to pale blue in the female and young male, or intense azure blue in the mature male. In the centre of the root of the tail is a large black spot, diamond-shaped, or roughly circular in outline, and partly enclosed by the last pair of grey or blue markings. In life the chromatophores of this spot are subject to control, and it is occasionally inconspicuous. Usually, however, it is very conspicuous in life; always so, according to our experience, *post mortem*, and is not affected by either alcohol or formaline. Another similar spot occurs on the male a little behind the base of the pectoral.

The caudal spot offers a ready method of recognising the species, being, when the chromatophores are (as usually) expanded, of a full intense continuous black, whereas the dark markings which occur in the same place in some other species are easily resolved by the naked eye into aggregations of minute black specks without any regular outline.

The spinous dorsal has three, the soft dorsal three or four horizontal bands of red or pink, the intervening parts of these fins being yellowish or milky white—blue in the adult male when viewed against a dark background. The remaining fins are without conspicuous colouration.

Among fish of adult size the male differs from the female at all times in the greater brilliance and boldness of his colouration. The blue element becomes especially conspicuous in moments of excitement. The posterior rays of the soft dorsal and anal are comparatively longer in the adult male than in the female.

Total length, 64 mm. ($2\frac{1}{2}$ inches).

The wide interorbital space, the number of rays in the spinous dorsal, and the conspicuous black spot at the root of the caudal fin (which, as already mentioned, seems to be retained, however the specimen is preserved), render the identification of this species a matter of little difficulty even in its youngest stages.

In somewhat marked contrast to our other gobies, *G. Ruthensparri* does not appear to habitually rest on the bottom, but swims, in larger or smaller shoals, among oar-weed (Laminaria) and mill-seed or sea grass (Zostera) at a short distance above the bottom, usually in quite shallow water. It can cling with some tenacity to an object by means of the ventral fins, and may probably take advantage of this faculty in rough weather.

The breeding season continues throughout the summer from April to August, and during this period there is a constant succession of broods; the breeding habits have been excellently described by Guitel (*loc. cit.*), and appear to resemble those of other gobies; perhaps the most notable point about them is the very small number of casualties which result from the persistent but discreet combats which take place among the males for their mates. The eggs seem to be laid upon any sheltered and fairly smooth surface, *e. g.*, inside the "hulbs" of *Laminaria bulbosa*, and are pear-shaped, with a somewhat pointed apex, measuring about ·8 mm. in height by ·6 mm. in greatest breadth. So far as any conclusions can be drawn from merely examining specimens of a species with such an extended breeding season, it appears that members of this species do not ordinarily survive the second winter following the summer in which they are hatched; but, as we have never kept specimens for a long period in captivity, we can do no more than express an opinion upon this point.

This species appears to occur in suitable localities on all our coasts, and its range extends from about 65° N. on the Norwegian coast to the Bay of Biscay.

GOBIUS MINUTUS, L.

Common Goby, Freckled Goby.

G. minutus and *G. Parnelli*; *Day*, I., p. 164 (1884); *G. minutus*, *Guitel*, Arch. Zool. Gen. et Exper. ser. II. x., p. 499, pl. xxii. (1892).

G. minutus and *G. microps*, *Petersen*, Fiskeri-Beretning Kbhvn, 1891, p. 246, pl. v., 10-12 (1892); *Smitt*, I., pp. 256-262 (1893).

D. VI. (VII.), 9-12; A. 9-12; Sc. 39-65, tr. 13-19. Habit, moderately stout, subject to considerable variation in form; head somewhat depressed; depth of body, $5\frac{2}{3}$ to nearly 8 times in total length; head, 4 to $4\frac{1}{2}$ times; eye, 3 to 4 times in head, usually somewhat larger than, but sometimes equal to or even shorter, than the snout, which is contained 3 to 5 times in head; interorbital space, narrow; scales, larger on the posterior part of the body than anteriorly; head, and a larger or smaller area of the front part of the back, scaleless; pectoral fins, without silk-like upper rays.

Colour very variable, sandy-brown or ochreous to dull grey, darker on the back and usually most intense along the exposed edges of the scales—a condition which results in an irregular and discontinuous network of darker colour over the dorsum and upper parts of the sides. There is commonly a series of dark blotches varying in intensity and number (from as few as six or seven to over a dozen) along the middle line of the sides, terminating in a somewhat more conspicuous group of black chromatophores at the base of the caudal fin; some of these blotches are sometimes prolonged into vertical bars. The dorsal and caudal fins are obliquely banded with brown or brownish-grey,* and there is usually a single conspicuous† black or deep blue spot at the posterior end of the spinous dorsal (when, as sometimes happens, this fin has seven rays there may be two such spots).

In the breeding male the colour of the body is usually darker, and there is often a marked tendency for the lateral blotches to form bars; the head and body are stouter and thicker set, the snout somewhat shorter and blunter, and the caudal peduncle comparatively deeper than in the female. The ventral fin and underside of the head become suffused with dark pigment, and the posterior rays of the soft dorsal and anal fins are prolonged and edged with blue-black, the bands on both dorsal fins become dull red or reddish brown, and the interspaces between them of a bluish tint, while the dark spot on the first dorsal becomes an intense and often brilliant blue, surrounded by an opaque white ring. These sexual characters seem to be developed to very different extents by different individuals, and are seemingly lost after breeding has ceased, the brilliant colouration soon fading, and the prolonged fin-rays sloughing away more gradually. The anal papilla of the male is long and pointed; that of the female short and blunt.

Total length, over 80 mm. (3¼ inches).

There appear to be two main races of this very variable species:

(A.) Typical race.

(*G. minutus major*, Heincke.)

D. VI. (VII.), 11-12; A. 10-12; Sc. 53-65, tr. 14-19.

Generally slighter in build than the estuarine race, with a lighter and finer head and a larger average number of scales and fin-rays; the scaleless area of the head and anterior part of the back only extends as far back as the front rays of the spinous dorsal. Usually of a sandy-brown or ochreous colour, without any very marked tendency to the extension of the lateral markings into bars.

Total length, over 80 mm. (3¼ inches).

Usually found on our coasts in water of normal salinity at all depths down to about 50 fathoms, commonest between low-tide mark and 20 fathoms. This race is very variable in form and colour, but specimens from deeper water seem usually to be longer, slighter in build, and paler in colour, and to retain some of their larval characters to a comparatively large size.

* Very rarely black on the spinous dorsal.

† Only inconspicuous, according to our experience, in some examples from deep water. One such, though of a size at which even the larger of the inshore forms is commonly mature, had fin-rays and membranes as delicate as in young examples, or as in the adult *G. Jeffreysii*. (See p. 63.)

(B.) Estuarine race. Fig. 3.

(*G. microps*, *Kroyer*, Danm. Fiske (1838-1840), and subsequent Scandinavian authors; *G. Parnelli*, *Day* (1884).)

D. VI., 9-11; A. 9-11; Sc. 39-55, tr. 13-19.

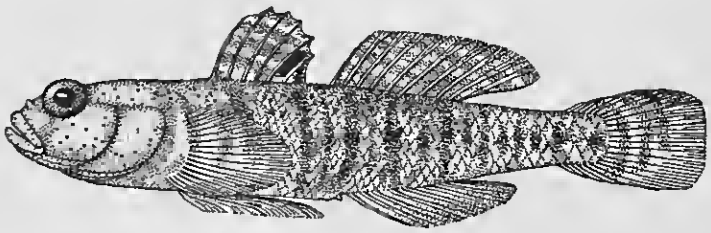


Fig. 3. *G. minutus* ♂ × 1½.*

Generally stouter in habit than the preceding race, with a heavier and hlunter head and a smaller average numher of fin-rays and scales; the scaleless area of the head and anterior part of the back is somewhat larger, extending as far as the posterior end of the spinous dorsal, and at some distance from it, hut is not constant in shape and size; this larger scaleless area in part accounts for the smaller numher of scales in a longitudinal series. This race does not attain such a large size as the typical race, is dirtier and greyer in colour, and especially in males, frequently has the dark hody markings prolonged into hars.

Total length, ahout 60 mm. (2¼ inches).

Specimens of this race from different localities differ considerahly from one another, more especially in size and in the extent of the scaleless area and numher of scales, and these differences seem to he in some degree the results of the hahitat; the largest and hrightest specimens we have seen came from the clean and sandy estuaries in the North of Cornwall,† where the water at high tide is of almost normal salinity [Fig. 3, and *post*, p. 64], and the smallest and most dingy specimens from the muddy and hrackish estuaries of the North Sea [*post*, p. 65]. The specimens from the estuary of the Cuckmere whose measurements are given on p. 64, approach the typical race in the comparatively large numher of scales and small scaleless area, though in form and colour they resemhle the estuarine race. In all prohahility a sufficient series of specimens from various localities would show a complete gradation from one race to the other.

The form termed *G. microps* hy the Scandinavian writers, which occurs in the shallow and nearly fresh waters of the Baltic, appears to mark the extreme development of this race. In appearance it is so different from the typical *G. minutus* as to appear specifically distinct, hut after examining specimens kindly sent us hy Professor Petersen, we can only regard it as the ultimate result of a variation whose earlier developments are seen in the estuarine forms of the Western Channel and North Sea.

It is not usually difficult to distinguish *G. minutus* from any other of our native gohies; in the case of the typical form, the numher of scales and radial formula are quite distinctive in cases where the

* The colouration scheme in the typical race only differs in the absence or less development of the dark vertical bars on the sides.

† Almost identical specimens were found by Guitel in the sandy bays of Brittany, and a very similar form occurs in the Exe estuary.

"freckled" appearance of the body and the nature of the markings on the body and fins are not sufficient for identification. Some estuarine forms resemble *G. pictus* in these respects rather closely, but *G. minutus* never has the plainly-marked rows of black spots on the dorsal fins which are found in that species, and as *G. pictus* appears never to be truly estuarine in habitat, confusion is not very likely to occur.

In one or other of its forms, this species appears to be almost ubiquitous on our coasts; it is apparently able to accommodate itself equally well to deep water in the open sea and to the dirtiest and most brackish estuary (where its usual companion is the three-spined stickleback), even living, and seemingly breeding, in small almost fresh puddles, quite beyond the reach of ordinary tides. The ground upon which *G. minutus* is usually found is either sandy or muddy, and never (in our experience) gravelly or rocky, but it seems to prefer places in which it can find empty shells, small stones, old cans, or other extraneous substances, to provide it with suitable shelter and sites for breeding; the presence or absence of weeds seems not to affect it. Essentially a gregarious fish, it usually occurs in large numbers in its favourite haunts, either resting on the bottom or half buried in the sand, or darting rapidly from one shelter to another, as it is disturbed. The breeding season lasts throughout the spring and summer, and on its approach each male selects a breeding site, usually under an empty shell or stone; having taken possession of this, he proceeds to carefully cover every entrance but one, and then hollows out a space in the sand or mud in his chosen shelter, and waits with his head outwards for the approach of a rival male, against whom he may sally out to battle or a female before whom he may display the full glory of his nuptial dress. The combats between rival males are furious and not infrequently result in the death of the weaker, perhaps as much from exhaustion as from wounds. Having finally induced a female to enter his home, the male mounts guard outside while she deposits her eggs, and on the completion of this operation again enters and watches over them until they hatch, preventing the approach of enemies, and keeping up a circulation of water round the ova until the young emerge. The female takes no further interest in her offspring, but proceeds after a short interval to lay another batch of eggs for some other male to protect. There appears to be a constant succession of broods throughout the spring and summer, and no sooner is a male relieved of the cares of one family than he takes upon himself those of another.

A most delightful account of the breeding habits of this species is given by Guitel,* whose observations are entirely borne out by what we have ourselves seen.

The ova are attached to the surface upon which they are laid by a micropylar net-work similar to that found in other gobies, and are of a more or less elongated pear-shape, varying considerably in size according to the size of the parent; those of the typical form are usually from 1·1 to 1·2 mm. in height, those of *G. microps*, described by Petersen, were only ·9 to 1 mm. in height. The young when hatched already have their mouths open and yolk sacs nearly absorbed, and soon attain the form of the adult. Probably the life of this species seldom extends over two winters; a specimen kept in a tank at Plymouth attained a length of 75 mm., and was fully adult about a year after the probable date of hatching.

* *loc. cit.*

The geographical range of *G. minutus* extends from 69° N. on the Norwegian coast to the Adriatic.

Its food consists of any animal substances it can swallow, but is mainly composed of small worms and crustaceans.

GOBIUS PICTUS, Malm.

Painted Goby.

Pl. II. Fig. 1.

G. pictus.—Day I., p. 167; *Holt and Byrne*, Jour. M.B.A., V., p. 336 (1898).

D. VI., 9-10; A. 9-10; Sc. 35-41, tr. 10-13.

Habit, moderately stout; depth of body, 5½ to 7 times; length of head, 4 to 5 times in total length; snout, 4½ to 5 times; eye, about 3¼ (in full grown) to 2½ (in young) times in length of head; inter-orbital space, narrow; scaleless area of head and back similar in area to that of the estuarine race of *G. minutus*.

Pale yellowish grey to pale brown in colour, boldly marbled with darker shades of the same colour; there are the usual paler dorsal saddle-shaped markings and darker patches on the head and operculum, and dark brown and yellowish grey patches on the region of the lateral line; these latter markings not infrequently (and more usually in males) take the form of perpendicular yellowish grey or dull ochre bars. Usually the centre of each dark area has a fairly conspicuous group of black chromatophores and the markings are much bolder in character than those of *G. minutus*. The dorsal fins are longitudinally banded with red, and bear one or more rows of black spots *

In the breeding male the colours are much intensified and there is a much greater contrast between the pale and dark markings; the dark markings in the region of the lateral line usually show a more or less marked tendency to form perpendicular bars, and some of the other markings in that region show a distinct opalescent play of colour; the membrane of the dorsal fins becomes a brilliant opalescent green or azure blue, and the black spots on them a deep blue-black.

Total length, 55 mm. (2¼ inches).

It is not easy to find any single character or even combination of characters (apart from the colouration) by which *G. pictus* may be readily distinguished from *G. minutus*. In the former species the head is as a rule stouter and the snout shorter in comparison to the eye, and the number of scales in the lateral line smaller; but the former character is apt to vary somewhat according to sex, and the latter is, in view of the irregular arrangement of the scales and of the fact that in some of the estuarine forms of *G. minutus* their number may be no greater than in some *G. pictus*, unsatisfactory. Indeed both the form and proportions of the head and the number of scales appear in the breeding males of some races of *G. minutus* to be practically identical with those found in *G. pictus*. Both these points are shown in the tables (pp. 59-66). The markings of

* Our coloured figure is taken from a pale specimen, and the body colours are often much darker and the black spots on the dorsal fins larger and more numerous than there represented.

the body are bolder in *G. pictus* than in *G. minutus*, and the rows of black spots found on the dorsal fins of *G. pictus* do not occur in *G. minutus*,* and, as they appear to be permanent in alcohol and formol, provide, in our opinion, the readiest means of telling these two species apart. As far as our experience goes, however, the number of the scales and the proportions of the head nearly always serve, if not to identify this species without recourse to the colours of the dorsal fins, at least to render more certain any identification founded upon that character. It appears that *G. pictus* is not a species liable to great variation, and in this it contrasts strongly with *G. minutus*. We have examined the otoliths of a few examples of each species, and have found them to present a slight but constant difference.

G. pictus is found on fine or coarse sand, on the muddy sand of Zostera beds, and on shelly or even gravelly ground, its preference, so far as we know it to exhibit one, being for coarse sand. It ranges from between tide-marks to about 15 fathoms, and though often taken in company with the last species, it neither penetrates into such deep water nor so high up estuaries. The breeding habits, so far as observed, resemble those of *G. minutus*, and the males are equally bellicose. The ova are pear-shaped, and measure about ·80 mm. in height by ·65 mm. in greatest breadth; the female commences to breed at a length of about 28 mm., and probably produces a series of batches of eggs in the course of the summer.

G. pictus has never been found south of our islands, but its range extends as far north as the Baltic. In our area it is abundant on the south of Devon and Cornwall, and in the West of Ireland, and has been recorded from Wales; in all probability it occurs all round our coasts in suitable localities.

GOBIUS JEFFREYSII, Gthr.

JEFFREY'S GOBY.

Fig. 4.

G. quadrimaculatus.†—*Day* (*nec. auct.*), I., p. 168 (1884).

G. Jeffreysii, Günther, Proc. Roy. Soc., Edin., xiv., p. 120, *partim* (1888); *Smitt*, I., p. 261 (1893); *Holt and Calderwood*, Sci. Trans. Roy. Dublin Soc., Ser. 2, v., p. 420 (1895); *Holt*, Jour., M.B.A., V., p. 89 (1897); *Holt and Byrne*, Jour. M.B.A., V., p. 337 (1898).

Fig. 4. *G. Jeffreysii* × 1½.

D. VI.,‡ 9-10; A. 9-10; Sc. 26-29, tr. 7. Habit, slender; body, elongated; head depressed and somewhat pointed; depth of body,

* Very rarely (See p. 54) there may be rows of very insignificant black spots on the spinous dorsal of *G. minutus*.

† The true *G. quadrimaculatus* is a common Mediterranean species which has not as yet been found on our coast. Day figures and describes the present species under that name, but attributes to it in his description (although not in his figure) 37-40 scales in a longitudinal series, that being the number possessed by the true *G. quadrimaculatus*.

‡ Smitt figures a specimen with only 5 rays in an obviously injured spinous dorsal.

6 to 7 times; length of head, about 4 times in total length; eye, 3 to 3½ times in length of head; snout, 4 to 4½ times; eyes, almost touching superiorly.

General colour pale grey, mottled with rusty brown, with four conspicuous dark spots in the region of the lateral line. Dorsal fins pale bluish grey, with dark horizontal bands; their rays are comparatively long, and both rays and fin-membrane very delicate and easily torn or broken. Sometimes one or more of the central rays of the spinous dorsal are much longer than the others; this is possibly a sexual character of the male, but may occasionally appear merely as the result of injuries to the other rays. The breeding male is not known to possess any distinctive colouration, but the colours of the male* seem generally to be more pronounced than those of the female.

Total length, 47 mm. (nearly 2 inches).

This species can hardly he confused with any other found in our waters; the form of the ventral fins at once distinguishes it from *G. scorpioides* and *G. orca*, and the number of scales from *G. minutus*, while in fresh examples the rusty brown colouration is characteristic.

The ova and breeding habits are not known; we believe that the ova attributed by us to *G. Jeffreysii* (*loc. cit.*) were so attributed on insufficient grounds.

It is found in water of 19 to 180 fathoms depth, usually on mud, sand, or fine gravel, and appears to be confined to the western shores of Europe, from Stavanger Fjord and the Färöe Channel on the North to the mouth of the English Channel on the South. In our waters it has been recorded from the Färöe Channel, the Hebrides, the Clyde Estuary, the South-west coast of Ireland, and near the Eddystone Lighthouse.

We believe that our figure shows the true form of the spinous dorsal fin, but unfortunately, owing to the depth of the water in which it lives and the delicate nature of the fin-membrane, we cannot say we have ever seen a specimen of *G. Jeffreysii* which was beyond doubt uninjured.

GOBIUS SCORPIOIDES, Collett.

Pl. II. Fig. 3 (♂), 2 (♀).

G. scorpioides.—Collett, Ann. Mag. Nat. Hist., Ser. 4, xiii., p. 447 (1874), Forh. Vid. Selsk, Christ., 1874, p. 175, Pl. iii., Fig. 4-6; Tillaegsh, Forh. Vid. Selsk, Christ., 1874, p. 58; *Malm*. Goteborgs och Boh. Fauna, p. 651 (1877). *Lebetus scorpioides.—Winther*, Naturhist, Tidskr., Khhvn., Ser. 3, xi. p. 49 (1877), and xii., p. 18 (1879). *G. scorpioides.—Hansen*, Zool. Dan. Fisk., p. 36, Pl. vi., Fig. 7 (1885); *Lilljeborg*, Sveriges och Norges Fiskar I., p. 620 (1891); *Smitt*, I., p. 260 (1893); *Holt* and *Byrne*, Journ. M. B. A., V., p. 337 (1898).

D. VI., 9; A. 8; Sc. 28-30.

Habit, stout; depth of hody, about 5 times in total length; length of head about 4 times; eye, about 3½ times in head, slightly longer than snout; ventrals without basal membrane.

*The specimen described and figured by Günther (Proc. Roy. Soc., Edin., xvi., p. 120) as the breeding male of this species is really referable to *G. orca*.

Colour yellowish, sometimes with a muddy tinge, with irregular dark madder-brown bands and markings, a broad and conspicuous pale band across the caudal peduncle. Spinous dorsal nearly black, with alternate red and white horizontal bands on its anterior margin; soft dorsal whitish, obliquely banded with pale red. In the breeding male the yellow ground colour has a distinct red tinge, and the brown pigment is more generally distributed and richer in tone, both dorsal fins are obliquely banded with red and white, and the two colours are separated by narrow black bands; there is a brilliant blue spot at the posterior end of the spinous dorsal.

Total length, less than 1 inch. The largest breeding male we have seen was 21 mm. long, and a female 21 mm. long contained ripe ova.

The stout babit, the form of the spinous dorsal and the pale band on the caudal peduncle, combined with the form of the ventrals, seem to provide the best means of identifying this species.

Nothing is known of the habits of *G. scorpioides*, which has been found on rough ground in from about 2 to 74 fathoms of water. The ova apparently resemble those of other gobies, but are much smaller and spherical in shape; they are deposited in the summer months.

It is one of the smallest of known fishes, and little liable to capture by any ordinary method; in fact, excepting from Ballynakill Harbour, there are only five records of its capture, viz., two from the Norwegian coast, one from the Cattegat, one from Falmouth Harbour, and one, hitherto unpublished, from 30 mi. W.N.W. of Cleggan Head, 74 fath.

In Ballynakill Harbour it may occur in some numbers, since several specimens have been secured with an iron-wire dredge, fitted with mosquito net bag and worked so as to engage the ground as lightly as possible. Its chief haunt, *fide* Mr. G. P. Farran, is the outer edge of the bar of Fahy Bay, the ground consisting of fragments of Lithothamnia, littered with old shells and small stones The depth is about one to three fathoms.

GOBIUS ORCA, Collett.

Fig. 5.

G. orca.—Collett, Ann. Mag. Nat. Hist., Ser. 4, xiii., p. 446 (1874); Forh. Vid. Selsk, Christ., 1874, p. 172, Pl. iii., Fig. 1-3; Tillaeg, Forh. Vid. Selsk. Christ., 1874, p. 57. *Lebetus orca.—Collett*, Forh. Vid. Selsk, Christ., 1879, p. 34. *G. orca.—Collett*, N. Mag. Natur. Christ., xxix., p. 61, Pl. i., Fig. 1-2 (1885). *G. Jeffreysii.—Günther*, Proc. Roy. Soc., Edin., xv., p. 210, Pl. iii., Fig. B. (1888). *G. orca. —Lilleborg*, Sveriges och Norges Fiskar I., p. 616 (1891); *Smitt*, I., p. 259 [?Fig.] (1893). *L. orca.—Collett*, Result. Camp. Scient. Monaco, X., p. 41 (1896).

Fig. 5. *G. orca* × 1½.

D. VI.-VII., 9-11; A. 9-10; Sc. 25-28.

Habit, comparatively slight; form, subfusiform, somewhat compressed; head, $3\frac{1}{2}$ times in total length; depth of body, about 6 times; snout shorter than eye, which is contained about $2\frac{1}{2}$ times in head. Generally similar to the last species, but much more slender and greyish brown in colour, with a few indistinct dusky markings on the upper part of the body, and without any pale band on the caudal peduncle. Spinous dorsal higher than soft, and of an uniform dull black; soft dorsal dusky black, with a deep black upper margin separated from the rest of the fin by a row of white spots.

Total length, about $1\frac{1}{2}$ inches.

Only some eight specimens of this little known fish appear ever to have been taken, all on sandy ground and in water of 10 to 200 fathoms depth; five were found off the Norwegian coast, two off Sables d'Olonne, in the Bay of Biscay, and one (originally recorded as *G. Jeffreysii* ♂) in Kilbrennan Sound, in the Hebrides. The last specimen is in the British Museum, and it is from this that our figure, unfortunately owing to the state of the specimen somewhat of a "restoration," is taken.

In all probability this species occurs off our coasts in suitable localities, and should be carefully looked for whenever gear capable of capturing so small a fish is used. Nothing is known of its habits or breeding.

TABLES OF MEASUREMENTS OF EXAMPLES OF VARIOUS SPECIES OF GOBY FROM BRITISH AND IRISH WATERS.

These were all made by the same observer at different periods, and, in spite of the varying circumstances under which they have been made (sometimes at sea), and of the fact that some specimens were fresh and some had been preserved for varying periods, it is hoped that sufficient uniformity of method has been attained to make them useful for purposes of comparison.

In some cases notes made at the time of measurement or capture are added.

All measurements are in millimetres.* The measurements in the several columns are—1. Length; 2. Length, inclusive of Caudal Fin; 3. Head; 4. Snout; 5. Eye; 5A. Interorbital width; 6. Depth of Body; 7. Depth of Caudal Peduncle. The symbols ♂ and ♀ are used to express sexual maturity.

*These are taken to the nearest half-millimetre, and smaller differences are sometimes shown by the use of the symbol +; thus, 1·5+ means more than 1½mm. and less than 2mm.

GOBIUS NIGER.

Plymouth (September).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	Fin-rays. A.	Scales. Sc.	Scales. Tr.
(1)	93	117	22	5·5	6·5	17	10	VI 13	13	37	14
(2)	88	103	21	5	6·5	15	9	VI 13	12	38	15
(3)	86	104	21	5	6·5	15	9	VI 13	13	39	15
(4)	84	101	20	5	6	16	9	VI 13	11	37	14
(5)	83	99	20	5	6	16	9	VI 14	12	37	14
(6)	82	98	20	5	6	16	9	VI 13	12	36	14
(7)	80	97	20	5	6	16	9	VI 13	13	36	14
(8)	79	96	19	4·5	6	15	9	VI 13	12	39	14
(9)	78	94	18·5	4·5	5·5	15	9	VI 13	12	36	15
(10)	77	93	18	4	6	16	9	VI 13	13	37	15
(11)	75	89	17·5	4	5·5	14	8	VI 13	12	39	14
(12)	74	89	17·5	4	5·5	14	8	VI 12	12	38	14
(13)	73	88	17	4	5	13	7·5	VI 12	12	40	14
(14)	72	87	17	3·5	5	13	7·5	VI 13	12	37	15
(15)	66	78	15	3·5	5	11	6·5	VI 13	13	38	14
(16)	63	76	15	3	4·5	11	6	VI 13	11	40	15

Measured in the autumn when all had eeemingly finished spawning for eome time.

Ballynakill Harbour, Co. Galway (Summer).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	Fin-rays. A.	Scales. Sc.	Scales. Tr.
(1)	♂ 94	118	24	7	6·5	16	10·5	VI 14	13	37	13
(2)	♀ 96	116	24	6·5	7	22*	11	VI 14	12	38	14
(3)	85	104	22	6	6	16	10	VI 13	12	36	13
(4)	62	76	15	4	4·5	12	7	VI 14	12	36	14
(5)	46	57	11	2·5	3·5	9	5	VI 13	12	36	13
(6)	32	40	8·5	1·5	3	5·5	3	VI 13	12	36	13

* Nearly ripe, ovaries large and remains of a *Polynoe* in etomach.

(3), (4), and (5) were malee not breeding ; the two latter probably imm ature.

The lengths of the rays of the spinous dorsal were as follows in millimetres :—

(1) 13, 15, 21, 29, 13, 8, longest ray reaching base of 7th ray of soft dorsal.
(2) 11, 13, 16, 18, 12, 7, „ „ 3rd „ „
(3) 12, 15, 17, 18, 15, 7, „ „ 4th „ „
(4) „ „ 3rd „ „
(5) „ „ 1st „ „
(6) „ not reaching beyond base of spinous dorsal.

GOBIUS PAGANELLUS.

INISBOFIN, Co. GALWAY (various dates).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	Fin-rays. A.	Scales. Sc.	Scales. Tr.
(1)	♂ 85	101	22	5	6	17	11	VI 15	12	55	20
(2)	♂ 85	101	22	4·5	5	17	11	VI 15	13	54	21
(3)	76	91	18	4	5	15	9·5	VI 15	12	58	22
(4)	67	80	16	4	5	13	8	VI 15	13	54	19
(5)*	62	74	15	3·5	4	11·5	7	VI 15	13	55	20
(6)	59	70	14	3·5	4	10·5	6·5	VI 14	12	54	20
(7)*	57	68	14	3·5	4	10	6	VI 15	13	55	18
(8)*	57	69	14	3·5	4	10·5	6·5	VI 15	13	53	18
(9)*	54	65	13·5	3·5	4	10	6	VI 15	13	56	21
(10)*	53	64	13·5	3	3·5	10	6	VI 15	13	52	19
(11)*	51	52	13	3	4	9	6	VI 14	11	53	18
(12)	48	58	12	3	3·5	9	5	V 14	12	55	20
(13)	47	57	12	3	3·5	9·5	6	VI 14	13	55	20
(14)	46	56	11·5	2·5	3	8·5	5·5	VI 15	12	55	19
(15)*	31	37·5	8	2	2·5	6	3·5	VI 15	12	57	19
(16)*	30	36·5	8	2	2·5	6	3·5	VI 15	12	53	20
(17)	27	33	7	1·5+	2·+	5	3	VI 15	12	53	18

*Collected early in September.

GOBIUS FRIESII.

OFF CLOGHER HEAD, 20–22 FATHOMS (January).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	Fin-rays. A.	Scales. Sc.	Scales. Tr.
(1)	72	90	16·5	4	6	13	6·5	VI 15	14	29	9
(2)	67	83	16	4	6	13	6	VI 15	14	28	9
(3)	66	85	16	3·5	5	13	7	VI 15	14	28	8
(4)	65	83	16	4	6	12	6	VI 15	14	29	9
(5)	65	81	16	4	6	13	6	VI 15	14	29	8
(6)	63	79	15	3·5	5·5	13	6·5	VI 15	14	29	9
(7)	61	80	15	3·5	5·5		6·5	VI 14	13	29	8
(8)	48	60	12	2·5	4	8	5	VI 14	13		

GOBIUS RUTHENSPARRI.

Ballynakill Harbour, Co. Galway (August).

	1.	2.	3.	4.	5.	5A.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	55	64	11·5	2·5	3·5	2	VII	11 11	38	12
(2)	51	60	11	2·5	3·5	2	VII	11 11	38	13
(3)	51	60·5	11	2·5	3·5	2	VIII	11 11	38	14
(4)	46	54	10	2	3	2	VII	11 11	40	13
(5)	45	53	10	2	3	1·5	VII	10 10	37	14
(6)	45	53	10	2	3	1·5+	VII	11 11	38	13
(7)	44·5	52·5	9·5	2	3	1·5+	VII	11 11	37	14
(8)	42	50	9·5	2	3	1·5+	VII	11 10	36	12
(9)	40	47·5	9·5	2	3	2	VII	11 11	39	12
(10)	39	47	9	1·5+	2·5+	1·5+	VII	11 11	36	13
(11)	38	45	8·5	1·5	2·5	1·5	VII	11 11	37	12
(12)	38	43·5	8·5	1·5	2·5	1·5	VII	11	38	12
(13)	37	43	8·5	1·5	2·5	1+	VII	11 11	37	12
(14)	37	43	8·5	1·5	2·5	1·5	VII	11 11		
(15)	37	43	8	1·5+	2·5	1·5+	VII	11 11	39	13
(16)	36	42	8	1·5+	2·5	1·5	VII	11 11	39	12
(17)	36	42	8	1·5	2·5	1·5	VII	11 11		
(18)	34·5	40 5	8	1·5	2·5	1·5	VII	11 11		
(19)	30	35·5	7	1+	2+	1+				
(20)	28	33	6·5	1+	2+	1+				

Inisbofin, Co. Galway, in Harbour (August).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	50	59	11·5	2·5	3·5	10	4·5	VII	11 11	38	12
(2)	47	55	10·5	2+	3+	8	4	VII	11 10	36	13
(3)	46	54·5	10	2	3	8	4	VII	11 11	40	15
(4)	46	54	10	2	3	9	4·5	VII	11 10	39	13
(5)	44	52	9·5	2	3	7	3·5	VII	10 11	39	14
(6)	44	52	9·5	2	3	7·5	4	VII	11 11	39	13
(7)	37	44	8·5	1·5+	2·5	6	3	VII	11 11	40	15
(8)	35	42	8	1·5+	2·5	6	3	VII	11 11	38	13
(9)	23·5	27·5	5·5	1+	2	4	2			38	13
(10)	20·5	24	5	1+	2	3·5	2	VII	11 11		

GOBIUS MINUTUS.

Inisbofin, Co. Galway (August).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	♀ 72	82	16	4·5	4·5	12	5	VI	12 12	64	17
(2)	♀ 65	76	16	4	4·5	10	5	VI	12 12	64	16
(3)	♀ 65	75·5	15	4	4	10	5	VI	12 12	65	18
(4)	♀ 64	73	15	4	4	9	5	VI	12 12	62	16
(5)	♂ 63	73	15	4	4	9	5	VI	12 11	62	16
(6)	♂ 58	69	14	4	4	9	4·5	VI	11 12	66	17
(7)	♂ 55	64·5	13	3+	3·5	8·5	4	VI	11 11	61	15
(8)	♂ 55	64·5	12·5	3·5	3·5	8	4	VI	12 12	62	17

All spent (5) with some small ripe spermatozoa. Very slight traces of dark pigment on undersides of ♂ ♂, a slight tendency to bars in both sexes, perhaps slightly more marked in ♂ ♂, spot on spinous dorsal slightly more intense in ♂ ♂. Genital papilla very small in all.

Height and run of soft dorsal similar in both sexes, ♀ 9½/5, 8/4½, 7½/4, 7/4 ♂ 9/6, 7/5, 7/4, 8/4.

(9)	71	82	16·5	4	4·5	11	5	VI	12 11	66	18
(10)	68	78	16	4	4·5	10	5	VI	11 12	67	18

Inisbofin, Co. Galway (August).

	1.	2.	3.	4.	5.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	67	77	15	4	4	VI	11 12	60	15
(2)	64	74	15	4	4	VI	12 11	65	16
(3)	63	73	15	4	4	VI	12 12	63	17
(4)	63	74	15	4+	4+	VI	12 11	61	17
(5)	60	69	13·5	3	3·5	VI	11 12	64	16
(6)	58	68	13	3·5	4	VI	12 12	61	15
(7)	55	64	13	3·5	3·5	VI	12 11	64	15
(8)	55	64	13	3·5	3·5	VI	11 11	58	17
(9)	54	64	12·5	3·5	3·5	VI	12 12	60	17
(10)	52	61	12	3·5	3·5	VI	11 11	61	18
(11)	50	59	12	3	3	VII	12 12	64	17
(12)	49	58	12	3+	3	VI	12 11	60	17
(13)	49	57·5	11·5	3	3	VI	12 11	65	19
(14)	47	56	11	3	3	VI	12 11	63	19
(15)	46	55	11	3	3	VI	12 11	60	17
(16)	43	51	10	3	3	VI	12 11	59	16
(17)	41	49	10	3	3	VI	11 11	58	14
(18)	39	47	9·5	2·5	2·5	VI	11 11	58	16
(19)	39	47	9·5	3	2·5	VI	12 11	63	17
(20)	38	45	9·5	2+	2·5	VI	12 11	60	16

Cleggan Bay, Co. Galway (September).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	♂ 56	66	14	3	4	7·5	4	VI	12 12	62	16
(2)	♀ 51	60	12	3·5	3·5	7	3·5	VI	11 10	61	17

♂ with testes enlarged and full of ripe spermatozoa.
♀ Spent.
No tendency to bars in either specimen.
♂ with very marked dark pigmentation of ventral and anal fins and posterior part of soft dorsal; no marked dark pigmentation on throat; spot on spinous dorsal bright with an opaque white ring surrounding it.
Soft dorsal and anal much higher posteriorly in ♂, not in ♀.

♂ D. 8–9 mm. A. 5½–8 mm.
♀ D. 8–4 mm. A. 5–4 mm.

1, 2. Burford Bank, Irish Sea.
3. Off Clogher Head, 20–22 Fathoms (January).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	♂ 60	68	14	4	4	8	5	VI	12 12	53	
(2)	45	53	11·5	3	3·5	6·5	3	VII	10 11	51	
(3)	♀ 59	65	14	3·5	4	10	5	VI	12 12	57	

(1) shows four or five bars; (2), after preservation in formol, appears to have barely attained the colouration and characters of the adult.

Deepish Water (15 Fathoms) at Mouth of Ballynakill Harbour, Co. Galway (August).

	1.	2.	3.	4.	5.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	52	61	13	3·5	4	VI	12 12	57	16
(2)	45	53	11	3·5	3	VI	11 12	51	17
(3)	44	52	11	3	3	VI	12 12	51	15
(4)	44	52	11	3	3	VI	12 12	54	16
(5)	43	51	11	3	3	VI	12 12	57	16
(6)	42	50	10	2·5	3	VI	11 12	53	16
(7)	41	49	10	3	3	VI	11 10	55	15
(8)	40	47	9·5	3	3	VI	12 12	53	14
(9)	40	48	9·5	2·5	3	VI	12 12	54	14
(10)	38	45	9	3	3	VI	12 11		
(11)	36	42·5	8·5	2	2·5	VI	11 11		
(12)	34	40·5	8	2	2·5	VI	11 12		
(13)	33	40	8	2	2·5	VI	11 12		
(14)	32·5	39	8	2	2·5	VI	12 12		
(15)	32	38·5	7·5	2	2·5	VI	11 11		
(16)	30	36	7·5	2	2·5	VI	12 11		
(17)	28	34	6·5	2	2				

St. Columb Estuary, N. Cornwall (August).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	♂ 46	55	11	2·5	3	8	5	VI 10	10	43	
(2)	♂ 45	54	11	2·5	3	7	4·5	VI 10	10	45	
(3)	♂ 44	53	11	2·5	3	6·5	4	VII 10	10	45	
(4)	♂ 44	52	11	2·5	3	6·5	4	VI 10	10	45	14
(5)	♂ 44	52	10·5	2·5	3	6·5	4	VI 10	10	46	13
(6)	♂ 44	52	10·5	2·5	3	6	4	VI 10	10	42	
(7)	♂ 43	52	11	2·5	3	6	4	VI 10	10	47	14
(8)	♂ 40	47	10	2	3	6	4	VI 10	10	43	
(9)	♀ 51	60	11·5	2·5+	3+	9	4	VI 9	10	48	14
(10)	♀ 50	58	11·5	2·5	3	8	4	VI 11	10	43	14
(11)	♀ 48	57	11	2·5	3	8	3·5	VI 10	10	45	
(12)	♀ 48	57	11	2·5	3	7·5	3·5	VI 10	11	50	13
(13)	♀ 44	52	11	2·5	3	8	4	VI 10	10	47	13
(14)	♀ 44	52	11	2·5	3	6·5	3·5	VI 10	9	42	14
(15)	♀ 41	48	10	2·5	3	6·5	3	VI 10	10	43	
(16)	♀ 40	48	10	2·5	3	7	3	VI 10	10	42	

Water—part of open sea at high tide, clean and bright.
All breeding, ♂ ♂ strongly barred, no bars on ♀ ♀

Estuary of Cuckmere River, Sussex (April).

	1.	2.	3.	4.	5.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	44	53	10	3	3	VI 10	10	54	19
(2)	43	52	10	3	3	VI 9	9	53	19
(3)	43	51	10	3	3	VI 10	10	55	
(4)	42	51	9·5	3	2·5	VI 10	10	50	
(5)	41	49	9·5	3	3	VI 10	10	50	17
(6)	41	49	9·5	2·5	3	VI 10	10	52	18
(7)	38	46	9	2	3	VI 9	10		
(8)	38	45	9	2·5	3	VI 10	10		
(9)	35	42	8	2	2	VI 10	10		
(10)	33	40	8	2	2	VI 9	9		
(11)	26	32	6·5	1·5	2	VI 9	9		
(12)	25·5	30·5	6·5	1·5	2	VI 9	10		

Water—Brackish and very dirty.
No ♂ in breeding dress (7) nearest, very slight tendency to bars.
A small dirty-looking form.

Note.—Comparatively large number of scales in a longitudinal series and comparatively small scaleless area for a small estuarine form.

ALDEBURGH, SUFFOLK, ESTUARINE (April).

	1.	2.	3.	4.	5.	Fin-rays. D.		A.	Scales. Sc.
(1)	♂ 41	48	10·5	3	3·5	VI	9	11	40
(2)	♀ 39	46	9·5	2·5	3	VI	10	10	39
(3)	♀ 39	47	9·5	2·5	3	VI	10	10	41
(4)	♀ 38	45	9	2·5	3	VI	11	10	40
(5)	♀ 38	46	9	2	2·5	VI	10	10	40
(6)	♀ 37	44	9	2·5	3	VI	10	10	43
(7)	♂ 37	45	9	2	2·5	VI	10	10	43
(8)	♂ 37	45	9	2·5	3	VI	10	9	41
(9)	♂ 37	44	8·5	2	2·5	VI	10	10	41
(10)	♀ 36	44	9	2·5	3	VI	10	10	43
(11)	♂ 36	43	8·5	2·5	2·5	VI	10	10	41
(12)	♂ 36	44	8·5	2	2·5	VI	11	10	44
(13)	♀ 35	42	8·5	2·5	3	VI	10	—	42
(14)	♂ 34	41	8·5	2	2·5	VI	10	10	—

Water—Brackish, often in small pools beyond reach of ordinary tides
♂ ♂ with moderate tendency to bars.
A small rather dull form of subdued colour.

WELLS-NEXT-THE-SEA, NORFOLK (September).

	1.	2.	3.	4.	5.	Fin-rays. D.		A.	Scales. Sc.
(1)	♂ 32	38	—	—	—	VI	10	10	—
(2)	♂ 30	36	—	—	—	VI	9	10	—
(3)	♀ 41	48	10	2·5	3	VI	10	10	41
(4)	♀ 41	47	10	2·5	3	VI	10	10	43

Water tidal, but somewhat brackish. Very similar to last in general appearance.

GOBIUS PICTUS.

INISBOFIN HARBOUR, Co. GALWAY (August).

	1.	2.	3.	4	5.	6.	7.	Fin-rays. D. A.	Scales. Sc.
(1)	46	54	10·5	2+	3+	7	4		40
(2)	46	54	10·5	2+	3	7·5	4		
(3)	45	53	10	2	3	7·5	4		39
(4)	45	52	10	2+	3	8	4		
(5)	44	52	10	2	3	7	3·5	VI 10 9–10	
(6)	43	51	10	2	3	7	4		
(7)	43	51	10	2	3	8	4		37
(8)	43	51	10	2+	3	8	4		
(9)	43	51	10	2	3	7·5	4		40
(10)	42	49	10	2	3	7·5	4		40

Ballynakill Harbour, Co. Galway (August).

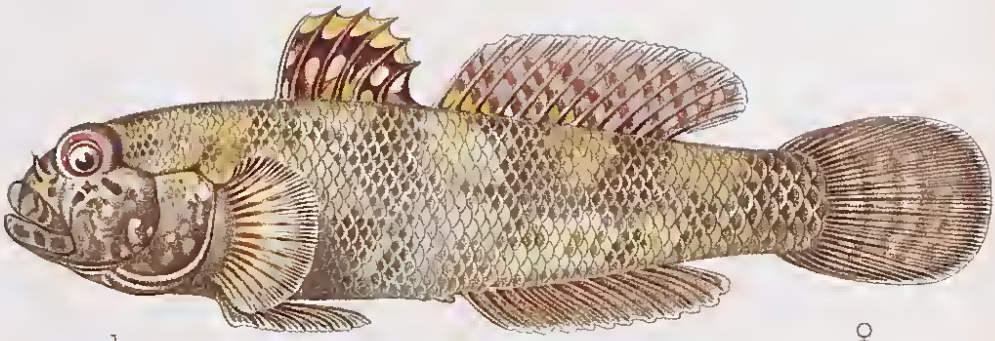
	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	44	51·5	10	2+	3	7	4	VI 10	10	40	11
(2)	43	50	10	2	3	6·5	3·5	VI	10	41	13
(3)	37	44	9	2	3	6·5	3	VI 10	10	35	13
(4)	♀ 32	38	7	1·5	2·5	5·5	3	VI 10	9	37	10
(5)	♀ 31	36	7	1·5	2·5	5·5	2·5	VI		40	11
(6)	♀ 30	35·5	7	1·5	2·5	5·5	2·5	VI 9	9	38	11
(7)	29	35	6·5	1·5	2·5	4·5	3	VI 10	10	37	10
(8)	♀ 28	34	6·5	1·5	2·5	5	2·5				
(9)	24	29	6	1+	2+	3·5	2				
(10)	23	27·5	6	1+	2	3·5	2				

G. JEFFREYSII.

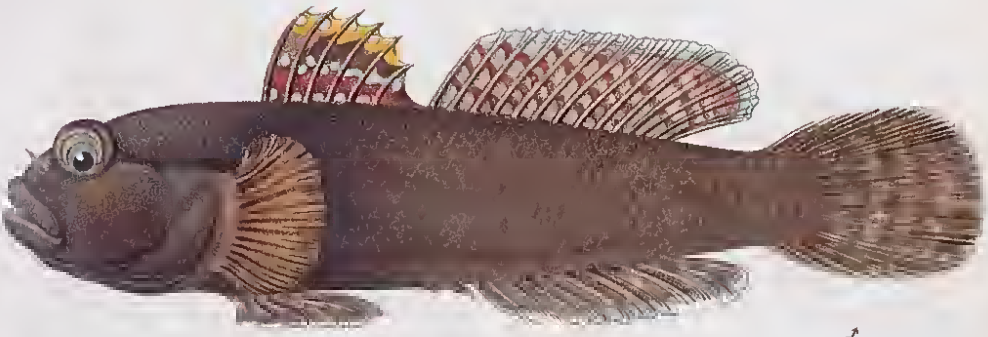
Plymouth, 4 miles inside Eddystone (September).

	1.	2.	3.	4.	5.	6.	7.	Fin-rays. D.	A.	Scales. Sc.	Tr.
(1)	39	47	10	2+	3+	6	3	VI 10	9	26	7
(2)	32	37*	8·5	2	2+	4·5	2·5	VI 9	9	*	7

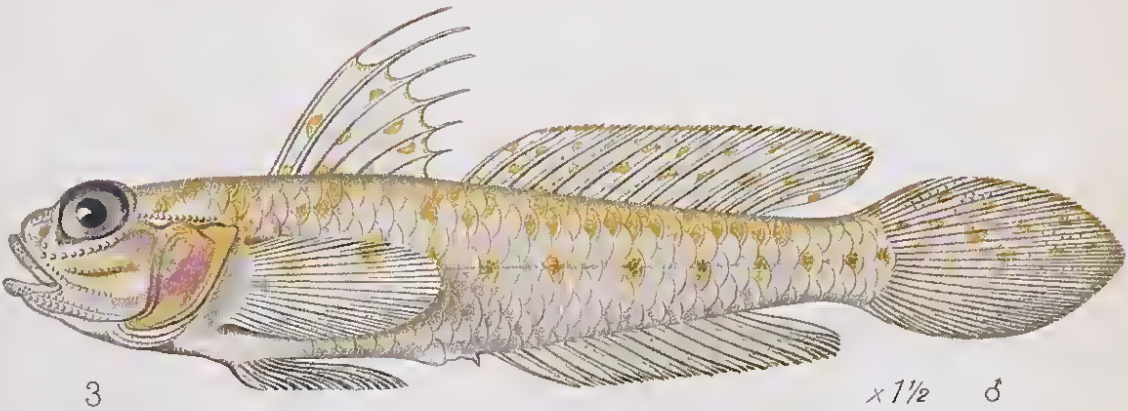
* Injured.



1 ♀



2 ♂

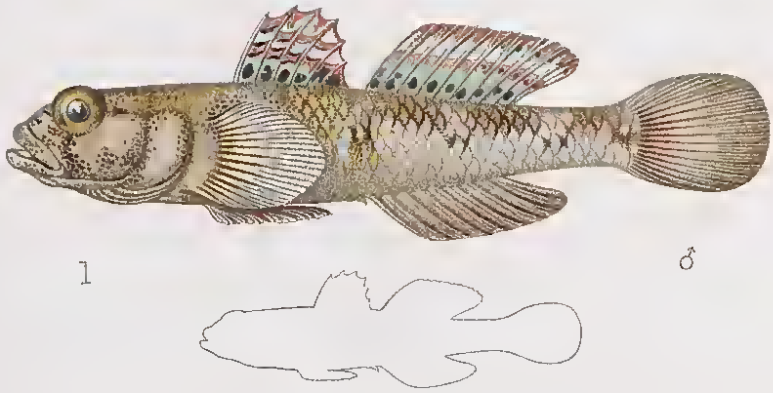


3 ×1½ ♂

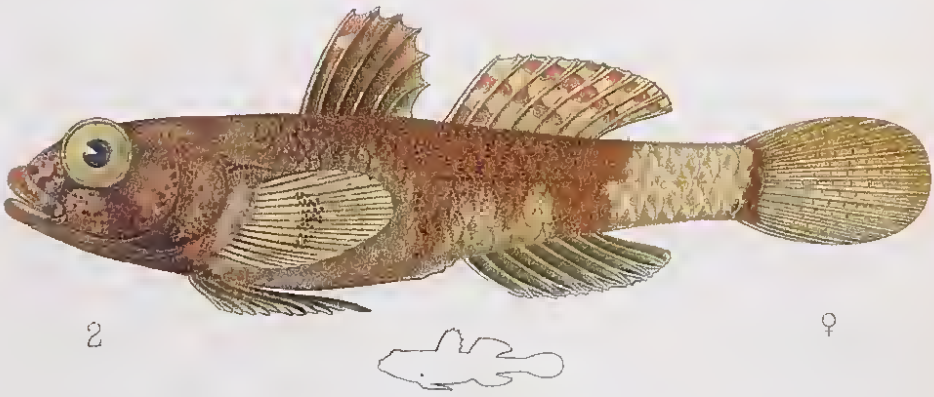
1 & 2 G M W after A J Holt
3 G M Woodward del

West, Newman chromo.

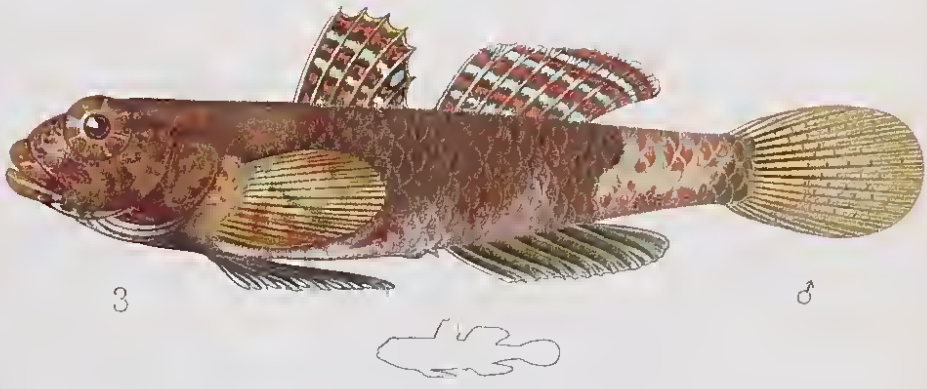
1 & 2. Gobius paganellus, *Gm. L.* ♀ & ♂
3 Gobius friesii, *Collett*, ♂



1 ♂



2 ♀

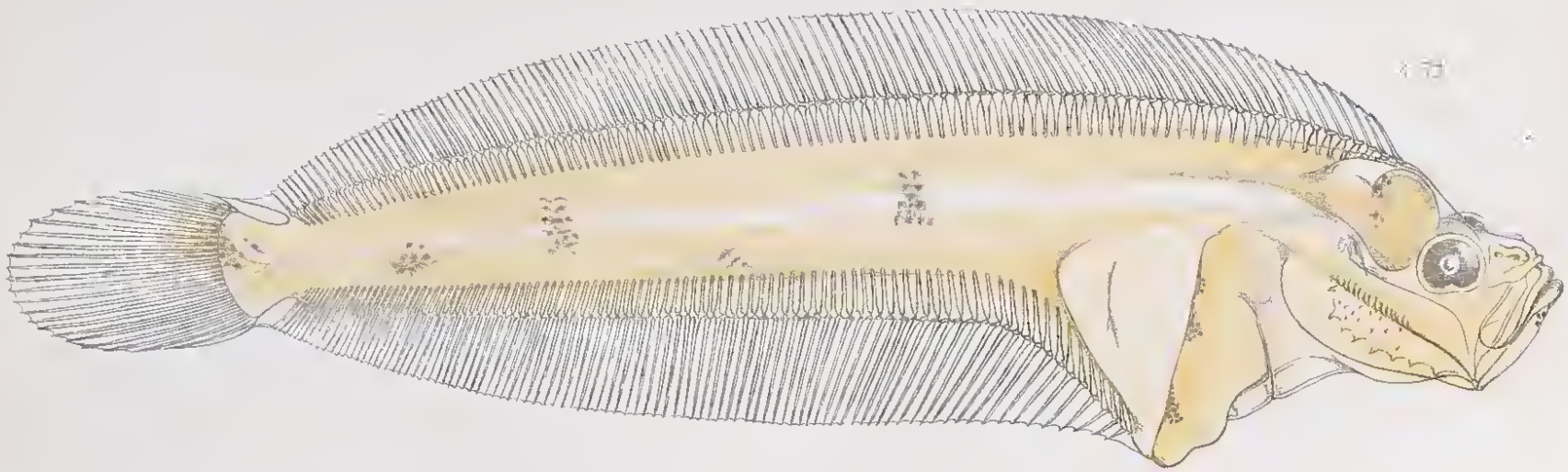


3 ♂

1&2, G M W after A J Holt
3 G M Woodward del

West, Newman chromo.

1 Gobius pictus *Malm*, ♂
2 & 3. Gobius scorpioides, *Collett*, ♀ & ♂



Pleuronectes cynoglossus

Appendix, No. IV.

ON A YOUNG STAGE OF THE WHITE SOLE,* *PLEURONECTES (GLYPTOCEPHALUS) CYNOGLOSSUS.*

BY

E. W. L. Holt and L. W. Byrne.

Plate III.

Our present knowledge of the life history of this species, shortly summarised in Cunningham's "Marketable Marine Fishes," p. 233 (1896), and McIntosh and Masterman's "British Marine Food Fishes," p. 372 (1897), is derived from the following papers:—

Cunningham, P.R.S., Edin., XXXIII., p. 101 (1886), ovum, vitelligerous larva, 3·99—5·9 mm.

Holt, Sci. Trans. R. Dub. Soc., ser. 2, IV., p. 455 (1891), ovum, V., p. 84 (1893), ovum, vitelligerous larva and early stage after absorption of yolk, 4·16—5·57 mm.; young, 42 mm.

Petersen, Rep. Danish Biol. Station, IV., p. 126 (1893), young 45 mm.

Goode and Bean, Oceanic Ichthyology, p. 430 (1895), young 57 mm.

We have in these papers a fairly complete account of the development and life-history of *P. cynoglossus* from the ovum to the termination of the vitelligerous stage of the larva at a length of 5·5 to 6 mm. Of its subsequent development nothing has been definitely known until the left eye has reached the summit of the head and the young fish has adopted the habits of the adult. This stage has been figured by Goode and Bean from the western side of the Atlantic; and somewhat more advanced specimens, from European waters, in which the migration of the eye has been completed, although the actual length is less, have been described and figured by Petersen, and by one of the present authors. To these stages should, in our opinion, be added (as will hereafter appear) the young pleuronectid of 32 mm. described by Petersen (*loc. cit.*, p. 130, fig. 20) and attributed by him, not without some hesitation, to the halibut (*Hippoglossus vulgaris*) rather than to the species now under consideration.

The length of the specimen which gives occasion for this note is 25·5 mm., of which the caudal fin occupies 3·5 mm.; the fin-ray formula is D. 108, A. 95; the vertebral centra cannot be accurately counted, but are certainly many more than fifty in number. Miss Woodward's drawing renders further detailed description unnecessary.

We refer it without hesitation to *P. cynoglossus* for the following reasons:—

(1.) The fin-ray formula, which is normal for *P. cynoglossus*: there are far too many anal rays for *H. vulgaris* or *P. hippoglossoides*.

* Witch (England), Craig-fluke (Scotland). For commercial purposes the Irish and English names are often also applied to the megrim or ox sole, *Rhombus* (*Lepidorhombus*) *megastoma*, a fish of less market value.

(2.) The elongated form and numerous vertebrae: the subgenus *Glyptocephalus*, Gottsche, is characterized by a very high number of vertebrae for pleuronectids; *P. cynoglossus* has 58, (*H. vulgaris* has about fifty only).

(3.) It agrees well in size and form with the known larvæ of *P. cynoglossus*, described by one of us from neighbouring localities. For comparison's sake it may be mentioned that a dab in the same stage as *P. cynoglossus*, 42 mm. long, is 15 to 16 mm. in length, while a dab in the same stage as the specimen under consideration (25·5 mm.) is about 10·5 mm. long, and the proportional increase in growth is almost identical.*

Petersen's larva, alluded to above, had a fin-ray formula of D. 104, A. 88, and was of a similarly elongated form, besides agreeing with our larva in the spinous armature of the gill-cover shortly to be noticed, and should therefore, in our opinion, be attributed to the same species.

P. cynoglossus, especially when immature, appears normally to live in water of greater depth than any other pleuronectid found on our coasts, excepting, perhaps, *Rhombus megastoma*, *Rhombus Boscii*, and the little-known *Solea Greeni*; on the Irish survey the young were always found in deep water, and the specimen now under consideration was taken in an ordinary tow-net sunk to 90 fath. on the eastern edge of the Porcupine Bank (90 mi. S. by W. ¼ W. of Cleggan Head, 175 fath.), 7th June, 1901.

The large number of vertebrae and porous nature of some of the bones of the head found in *Glyptocephalus* are, no doubt, correlated with a deep-sea habitat, and it is not improbable that the long duration of the pelagic stage and large size attained by *P. cynoglossus* before assuming the form and habits of the adult may be, in part, due to the same cause. A far more interesting feature in the development is the presence on the gill-cover of a spinous armature (see Fig. 3). Although the larvae of the "Psettine"† genera, *Rhombus* (*Psetta*) *Phrynorhombus*, and *Zeugopterus* have long been known to pass through a spine-bearing stage, we are not aware of its having been elsewhere found in a "Pleuronectine"† flat-fish. This spine-bearing stage appears to throw considerable light upon the origin of the Pleuronectidae. It seems reasonably plain that the presence of spines on the head or operculum cannot possibly be of any use to a fish which habitually lies with one side upon the bottom or even upon a perpendicular rock-face, and is far more likely to be an ancestral character derived from some such early Zeorhombine or Berycoid form, as Boulenger‡ suggests.

The presence of such spines in the Psettine Pleuronectids alone might perhaps be regarded as a secondary character; but when they are found to reappear in the only Pleuronectine form which we know to have a long larval history§ it seems difficult to interpret

* In such comparisons a margin must be allowed for the individual variation of length (in regard to stage of metamorphosis) so frequently observed in young flat fishes of any species.

† We only employ these terms as a matter of convenience, and in no way agree that there is any necessity to subdivide the *Pleuronectidae* into families and subfamilies, as has sometimes been done.

‡ Ann. Mag. Nat. Hist., ser 7, X. 295 [1902].

§ As inferred by the large size attained before the completion of the metamorphosis.

their presence otherwise than by supposing that the spine-bearing stage has been suppressed in the life-history of the Pleuronectine forms inhabiting shallow water. In these the early assumption of the adult form is commonly correlated with a migration to the extreme sandy margin in the spring and summer, where the conditions of life would be unfavourable to an incompletely metamorphosed larva. It is possible that small bottom-living animals, suitable for the food of the younger stages of a pleuronectid, are less abundant in the deeper water to which *P. cynoglossus* is at all known stages of its life-history confined. If this were so the retention of a prolonged larval history or its extension would be a necessary item in the evolution of the species. It is true that the dab (*Pleuronectes limanda*), though perhaps most abundant immediately after metamorphosis in shallow water, contrives to find a living at the same stage at depths well within the range of the adult white sole;* but the dab, at least when adult, is more markedly omnivorous than any other Pleuronectid of our acquaintance. An extended larval phase is not invariably associated in Pleuronectids with a deep-sea habitat, as is shown by the life history of *Arnoglossus Grohmanni*,† a small fish, confined in the adult form to shoal water, the larva of which, having regard to the ultimate size of the two species, attains dimensions relatively greater than the larva of the white sole.

The latter presents among British Pleuronectines structural characters which go far to justify its exclusion from the genus Pleuronectes, and as it recedes from this genus it tends to approach, in the number of its vertebræ and fin-rays, deep-sea habitat, and, perhaps, its larval history also, the Hippoglossine forms. The remaining forms may be roughly arranged in a series *P. microcephalus—limanda—platessa—flesus*, marked by (i.) the adoption of a more and more inshore habitat, (ii.) a decreasing number of vertebræ and fin-rays, and (iii.) a more and more restricted larval history.

* Advanced larvae of the white sole have, however, only been found so far at depths beyond the range of the dab; so the zones of depth suited to earliest bottom-living stages of the two species may be separated by a fairly wide interval, abridged in later life by the shoreward migration of the white sole.

† Previously known on the Irish coast by a few specimens at scattered localities. *A. Grohmanni* has, since 1890, proved to be common in shallow water in Ballynakill and Bofin harbours, and Cleggan bay, Co. Galway. In the adult form its range seems to be, in British and Irish waters, from tide marks to about ten fathoms.

Appendix, No. V.

ON THE BRITISH AND IRISH SPECIES OF THE FAMILY STROMATEIDAE.

BY

E. W. L. Holt and L .W. Byrne.

Plates IV. and V.

The occurrence upon our coast of a shoal of rudder fish, a species previously unrecorded from Irish, and only known from British waters by a single specimen, called for a note in this Report.

Although it is probable that several members of the family are not very rare visitors to this side of the Atlantic (if, indeed, one of them is not a constant resident on that biologically-defined, but by man undefinable, border which divides the ocean from littoral waters), but few authentic records of their occurrence exist. The species are not very easy to determine by reference to ordinarily accessible literature, and, as we have found, are liable to confusion in records which can only be checked by chance. We have therefore taken the opportunity to briefly define all the forms which are known to have occurred in our waters, in the hope that attention may he drawn to any instances of future occurrence, whereby our very scanty knowledge, not only of the life history and habit of the fish, but of the circumstances which induce their entry within the sphere of coastal fisheries, may be augmented.

Affinities of the Stromateidae.

As the description given by Regan* shows, the family *Stromateidae* must be placed in the sub-order *Percesoces*, as defined by Boulenger.† This sub-order is also represented in our fauna by the families *Scombresocidae*, *Ammodytidae*, *Atherinidae*, and *Mugilidae*, and is a group which marks the transition hetween the Haplomous fishes and the Acanthopterygians: at its two extremes it approaches both these sub-orders very closely, and it is almost impossible to find a combination of external characters, by which its members may be distinguished from those of the sub-orders *Haplomi* and *Acanthoperygii*. Anatomically the *Percesoces* resemble both these groups in (i.) the form of the roof of the skull, in which the parietals are separated by the supra-occipital, and (ii.) the nature and attachment of the pectoral girdle, which has no mesocoracoid arch and no clavicle (infraclavicle) distinct from the cleithrum (clavicle), and is suspended from the cranium: they differ from the Acanthopterygians in retaining the primitive feature of "abdominal ventral fins," that is, ventral fins whose supporting bones are either not attached to the pectoral arch or only attached to it by ligament, and from the *Haplomi* in having lost the open duct of the air-bladder. The fins are in some families devoid of spinous rays, as in the *Haplomi*, and in some they have acquired spinous rays, as in the more primitive Acanthopterygians.

* Ann. Mag. Nat. Hist., ser. 7, X., 115 (1902).

† Poissons du bassin du Congo, 348 (1901).

The *Stromateidae* (like the *Atherinidae* and *Mugilidae* in our fauna) have spinous rays in the dorsal, anal and ventral fins; but differ from the members of those families found in our seas (i.) in having the spinous portion of the dorsal fin continuous with its soft portion,* and (ii.) in having the ventral fins inserted so far forward that their "abdominal" nature is not apparent without dissection. They may be defined (so far as the genera already known to occur or likely to be found in our waters are concerned) as:—*Percesoces*: (1)† With ventral fins with one spine and five soft rays, situated below or only slightly behind the pectorals; (2) with spinous rays in the dorsal and anal fins,‡ which are in each case continuous with the soft articulated rays, but much fewer than the latter in number, and usually only feebly developed; (3)§ with the upper part of the head tumid and covered with a spongy porous integument; and (4) with lateral sacs in the oesophagus, which carry teeth internally.

As, however, the characters which show the *Stromateidae* to belong to the sub-order *Percesoces* are only apparent on an anatomical examination, and the external characters above alluded to may be of but little use in identifying damaged specimens, we consider that the most reliable diagnostic character of members of the family is the presence in the oesophagus of lateral sacs which carry teeth internally. So far as we know these are found in no other family of fishes,‖ and, although not visible on an external examination, their presence may be ascertained without injuring the specimen examined by making a small incision above the origin of the pectoral fin. In all probability the sacs, which are large and muscular, can be easily felt from the outside in fresh specimens.¶

Genus *LIRUS*.

Body ovate or oblong-ovate, compressed; mouth small or moderate; palate without teeth; premaxillaries slightly protractile; maxillary more or less exposed, with small supplemental bone. Upper surface of head with a spongy porous integument. Scales small; lateral line curved anteriorly, becoming straight before reaching the caudal peduncle.** [Regan.]

* An approach to continuity has been noted by one of us as an occasional feature in the young of Atherina (Ann. Mus. Marseilles, V., 52 (1899)).

† The ventral fins are absent (in the adult) in three genera, one of which, *Stromateus*, occurs in the Mediterranean.

‡ This serves to distinguish members of this family from the *Carangidae*, which they sometimes resemble in external appearance, but in which the spinous rays of the anal are separated from the soft rays.

§ This character is not universal in the family.

‖ The apparently allied *Tetragonurus* has, as Mr. Regan has shown us, similar sacs bearing soft papillae internally.

¶ We take this opportunity of expressing our indebtedness to Mr. Boulenger and to Mr. Regan for the assistance and information which they have given us, and to Dr. Günther for permission to copy the figure given by him of *L. medusophagus*.

** Among the members of the family known to occur in British and Irish waters a further distinction appears to be afforded by the process of the shoulder-girdle internal to the pectoral fins. In Lirus the upper edge of this projects from the side of the body, the skin being inflected over it. In Centrolophus the skin of the side passes over it without inflection, its outline being barely visible from the exterior.

Two species have occurred in our waters, hut only as stragglers.

1. Dorsal spines not distinct, graduating to the soft rays and four in number; scales about 140. *L. medusophagus.*

2. Dorsal spines distinct, shorter than soft rays, and eight in numher, scales, 80-90. *L. perciformis.*

Quite possihly other members of this genus may find their way to the British or Irish coast; a description of all the known memhers of the genus is given hy Regan, Ann. Mag. Nat. Hist., ser. 7, X., 115 and 194.

LIRUS MEDUSOPHAGUS, Cocco.

PLATE IV.

Schedophilus medusophagus, Günther, T.Z.S., XI., 223 (1882); *Day*, II., p. 367 (1884). *Lirus medusophagus, Regan*, Ann. Mag. Nat. Hist., ser. 7, X., p. 196 (1902).

D. IV 41-46. A. III 24-27. Sc. 136-148, $\frac{26\text{-}30}{60\text{-}70}$.

Body, moderately stout, ovate, and strongly compressed; hoth the skeleton and muscular tissues very soft. Depth, $2\frac{1}{4}$ to $2\frac{1}{2}$; head, 3 to 4 times in total length.* Eye 3 to 4 times in head, equal to or slightly shorter than snout, and less than interorhital width. Length of caudal peduncle (measured from a vertical from the posterior end of the hase of the dorsal) about twice in the length of the head. Dorsal spines, small and weak, connected with one another and with the soft rays by memhrane. Preoperculum armed with spines (which are proportionately longer in the young), other opercular hones with radial ridges which may project beyond their edges as spines. Dorsal, anal and ventral fin rays proportionately longer in the young.

Pale olive green in colour, with darker marblings; vertical fins with blackish spots.

Attains a length of $9\frac{1}{2}$ inches (240 mm.).

This fish is pelagic in hahit, and when young is met with at the surface of the open ocean,† hut as Günther‡ has pointed out, the singular lack of firmness in the tissues and hones of the adult seem to indicate a deep-sea hahitat; its food appears to consist of young fishes and other small pelagic organisms, and, like other members of the family, it is often found, especially when young, following large medusae and floating weed or wreckage, seemingly for the sake of feeding upon the small organisms which accompany such ohjects. It is from this habit that it derives its specific name, but it is not definitely known to actually eat medusae.

This species is a native of the Atlantic, Pacific, and Mediterranean; in August, 1878, a single specimen was captured in a salmon net at Portrush, whither it seems to have followed thc shoals of herring-fry upon which it had been feeding.

Our figure is taken from that of the Irish specimen above alluded to, given hy Günther (T.Z.S. XI., Pl. 47); the specimen itself is in the National Museum at Dublin.

* Exclusive, as throughout these notes, of the caudal fin, except when the maximum known size of the species is stated.

† *Lutken, Spolia Atlantica*, Vidensk. Selsk. Skr. Kbhv. r. 5, XII., 525 (1880), Pl. ii. fig. 9.

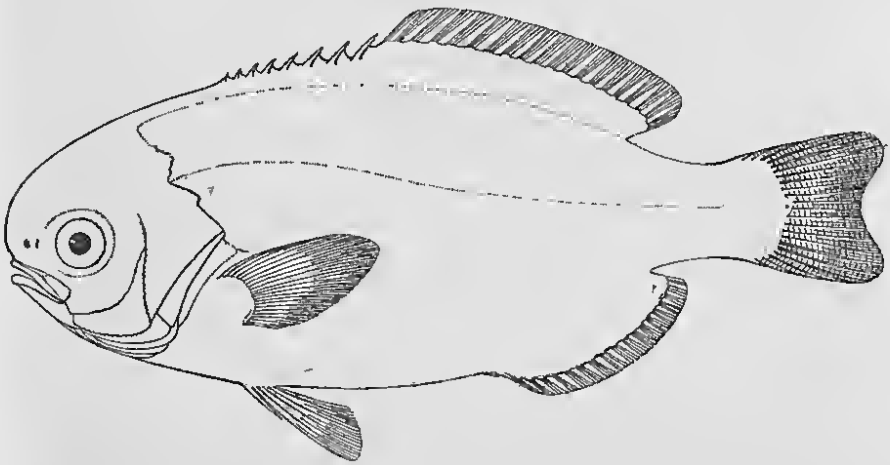
‡ Challenger, Deep-sea Fishes, 46.

LIRUS PERCIFORMIS, Mitchill.

BARREL FISH, LOG FISH, RUDDER FISH, BLACK RUDDER FISH.

Pimelepterus cornubiensis—Cornish, Zoologist (2) IX., 4255 (1874); *Pammelas perciformis, Day*, I., 130 (1884); *Lirus perciformis, Regan*, Ann. Mag. Nat. Hist., ser. 7, X., 202 (1892).

Centrolophus pompilus, Andrews, Proc. Nat. Hist. Soc. Dublin, VI., 70 (1871), *Day, loc. cit.*, p. 111, *partim.*



Lirus perciformis, × $\frac{1}{3}$.

D. VIII 19-21. A. III 16-18. Sc. 80-90, $\frac{12\text{-}14}{28\text{-}30}$. l.l. 72–75.

Body stout, ovate, and compressed. Depth, exclusive of the scaly sheath about the base of fin-rays, about $2\frac{4}{5}$ to $3\frac{1}{5}$; length of head about 3 to $3\frac{1}{2}$ times in the total length; snout obtuse,* equal to eye, 4 to $4\frac{3}{4}$ times in head, but much shorter than horizontal dimension of bony orbit;† bony orbit, about equal to length of upper jaw, about 3 times in length of head; caudal peduncle (from vertical of posterior end of base of dorsal to origin of central caudal rays), about 5 times in total length; bases of dorsal and anal fins concealed in a fleshy scale-clad sheath; dorsal spines stout and shorter than the soft rays, connected with each other in adults only by a triangular strip of membrane passing

* The profile of the head, correctly shown in our outline sketch, as also in the more detailed figures given by De Kay (Fauna of New York, Fishes, 118, pl. 42,) and Brown Goode (Fishery Industries, U.S.A. p. 334, pl. 112), appears to be due to the spongy nature of the cephalic integument and to the presence of muciferous chambers. Preservation in alcohol tends to reduce the profile to a slope from the highest part of the head to the snout, but in the old Dingle specimen, hereinafter referred to, the general shape of the head is not much altered. Day's figure, which is so unlike the natural condition as to be almost useless for identification, is a fairly correct rendering of the specimen from which it was taken, now in the British Museum. The collapse of the snout from an obtuse to an acute form is probably due, not only to the action of the preservative, but to the emaciation of the specimen, of which Day makes due note.

† The natural external dimensions of the eye are, we believe, correctly shown in our outline sketch; but in specimens which have been preserved in alcohol, the apparent dimensions may be considerably altered by shrinkage of the surrounding integument. In the old Dingle Bay example, for instance, the present external size of the eye is that of the bony orbit.

from the lower half of the posterior face of each spine to the base of the anterior face of the next;* colouration uniform purplish black, somewhat paler on the belly.

Attains a length of at least 13 inches.†

The complicated outline of the posterior face of the opercular apparatus, shown in Day's figure and in our sketch, is present in all the examples which we have seen. But Brown Goode's drawing, apparently taken from a specimen in good condition, suggests that in life the skinny covering of the scutes concerned completely masks their angularity. It would also appear from the figure that the colouration of the sides of the body may be diversified in life by irregular markings.

In America the fish, though not purposely sought by fishermen, appears to be regarded as possessing good table qualities.

A pelagic fish of the temperate North Atlantic, and by no means uncommon on the American coast, it shows a decided tendency to follow any floating object, probably for the sake of the barnacles thereto adhering. Its singular habit of ensconcing itself within floating barrels has attracted the attention of American fishermen, and is illustrated by the circumstances of capture of the first recorded British specimen, detailed below. Although it would appear (Brown Goode, *op. cit.*, p. 334) that it feeds also on other organisms, every known instance of its occurrence on the coasts of the United Kingdom can be associated with an object presumably covered with barnacles.

The earliest, and hitherto unrecorded, instance, we discovered by chance in examining the collections in the National Museum, at Dublin, in connection with the present notes. A jar bearing the legend "*Centrolophus pompilus*, Dingle Bay, presented by William Andrews, 1871," proved to contain perhaps the most perfect specimen of *Lirus perciformis* on this side of the Atlantic. It is possible to connect this specimen with Andrews' record (under *C. pompilus*), noted above, of a large shoal of fish playing over a piece of floating wreck on the Dingle coast in the summer of 1870.

A single specimen was captured off Penzance in October, 1874 (Cornish, *loc. cit.*) drifting in a broken fish-box, from which it was apparently unable to escape; it had been feeding upon the barnacles which were growing upon the box. On the 21st or 22nd September, 1901, a large shoal followed a barnacle-covered log ashore at South Island, Aran Islands, under the circumstances detailed by Mr. Colman Costello in the following letter:—

> "They came after a log of timber covered with barnacles, and were thrown ashore at the north-west corner of the South Island, where the Congested Districts Board is after building a breakwater and clearing the shore. At the time, owing to the tide being low, it was like a horse-shoe, so that if the islanders took twenty fathoms of net and put it across the entrance they would save thousands upon thousands of fish; but, instead of that, when they saw the fish, from a high ledge

* Our specimens from Aran have the spines entirely free, but in the Dingle example the membrane, which is as noted in our diagnosis, appears to be well preserved on some of the spines. It is probable that young examples have the spines more completely connected by membrane.

† The Dingle specimen now measures—snout to origin of caudal rays, 10¼ in.; to extremity of central rays of caudal, 11⅝ in.; to extremity of caudal fin, 13 in. It must have been slightly longer in life.

on one side, having the barnacles like a calf would have the teat of a cow in its mouth, they all got afraid, and said they were Sheeogues,* and then ran away, except one old man.

"At the time the log struck the shore about 400 of the fish jumped on dry land, and were hopping about on the shore, so that some of them got into the water again, while others died, and were carried away by the next tide, except two that the old man took home with him.

"When the old man came home, and his wife and sons saw the fish, they would not allow him to take them into the house, as they never saw the like before: they were no fish, but Sheeogues resembling fish. It was from this man that Mr. Costello† got them.

"When the log dried it appears the fish turned away to sea and scattered about. A man named * * * , with another, was fishing about half a mile from the shore in a canoe, with hand lines, a few days after, and was looking out over the side as the day was bright, and saw one of these fish swimming about very near the surface. He pulled ashore, and did not go out again for three days."

Genus *CENTROLOPHUS*.

Distinguished from *Lirus* by the elongated body and maxillary slipping under the preorbital for the entire length of its upper edge. Dorsal and anal spines slender, indistinct, and graduating to the soft rays.

Two species have been found in British and Irish waters:—

1. D. 45; A. 30. *C. britannicus.*
2. D. 37-41; A. 23-25. *C. niger.*

CENTROLOPHUS NIGER, Gm.

BLACKFISH, BLACK PILOT.

PLATE V.

C. pompilus, *Day*, I., 111 (1884); *Holt*, M.B.A. Journal II., 265 (1891).

C. niger, *Regan*, Ann. Mag. Nat. Hist., ser. 7, X., 195 (1902).

D. 37-41. A. III 20-22. Sc. 185-205 $\frac{23\text{-}28}{58\text{-}70}$.

Body moderately stout and subfusiform; depth, 4 to 5; head, $4\frac{1}{3}$ to 5 in total length. Snout, equal to or a little longer than eye, which is contained 4 to $4\frac{3}{4}$ times in head; interorbital width about $3\frac{1}{2}$ in head. Spinous portion of dorsal with about 3 spines, which are indistinct, and hardly pierce the skin. Bases of dorsal and anal fins masked by a fleshy scale-clad sheath, from which scales extend

* Sidheog, *Anglice* "little" or "young fairies," or dwellers in the lower world. It is a common belief that fairies, and even living people of occult powers, can assume the forms of animals.

†Mr. Michael Costello, of South Island, who, at the suggestion of Mr. Colman Costello sent these two fish, one of which is here figured, to the Congested District Board. They had been split and cleaned before coming into Mr. Costello's hands.

along the rays almost to their extremities. Colours variable; usually purplish or violet black, grey on the head and paler on the belly; sometimes with indistinct spots or marblings.*

Attains a length of 3 feet or more.

The blackfish is a pelagic fish of the Eastern Atlantic and Mediterranean, which is probably not uncommon on the offshore mackerel grounds at the mouth of the English Channel and on the west and south of Ireland, but is seldom recorded as British or Irish except when, like other members of the family, it follows ships or wreckage into shallow water, and is there captured. Several specimens have, in the course of the last year or two, been brought to us by mackerel boats fishing off Inishofin, Co. Galway, and one of us has (*loc. cit.*) recorded the capture of several young specimens off the Scillies. Our figure is based on an Irish specimen about 34 inches long, captured off Port Salon, Co. Donegal. It has occurred in the North Sea as far north as Aberdeen. Nothing is definitely known of its habits, breeding, or food; the young specimens above alluded to had been feeding upon small pollack, and at the western edge of our mackerel grounds, schools of young poutassou (*Gadus poutassou*) are probably not uncommon at the surface.

CENTROLOPHUS BRITANNICUS, Gthr.

Cornish Blackfish.

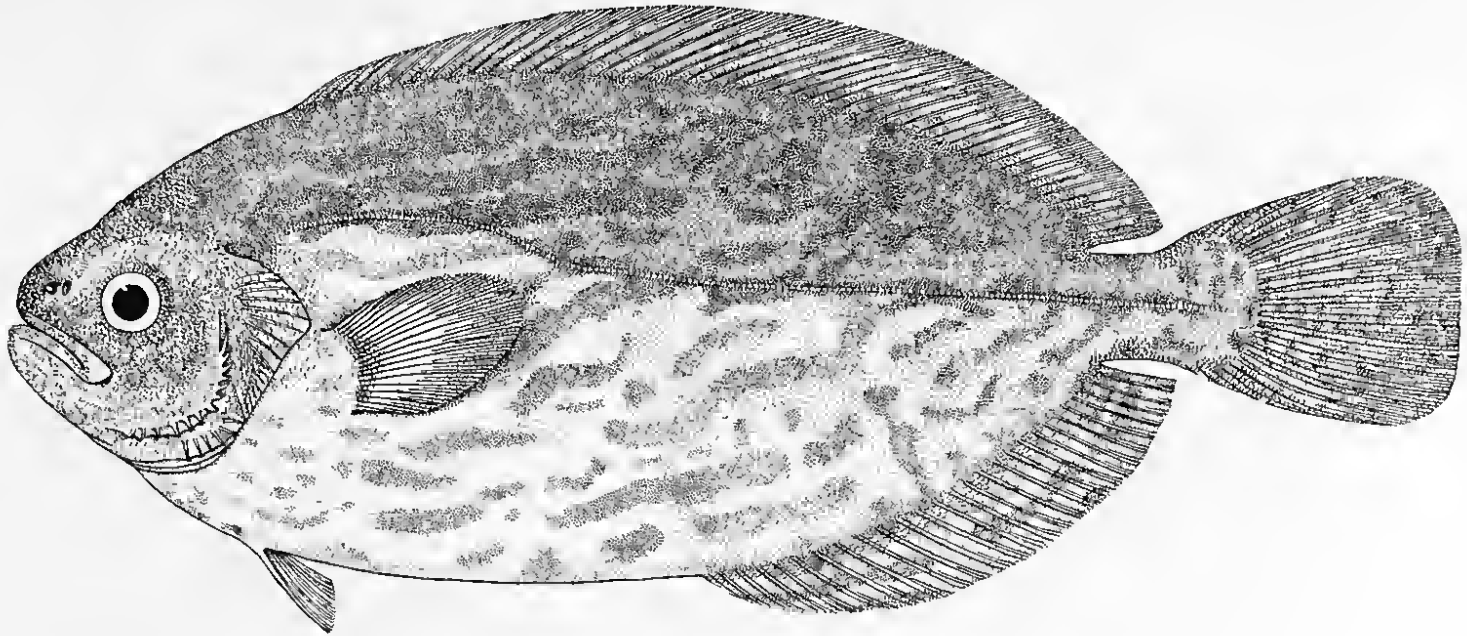
Günther, Cat. II., 402 (1860); *Couch*, II., 127 (1863); *Day*, I., 110 (1884).

Regan, Ann. Mag. Nat. Hist., ser. 7, X. 194 (1902).

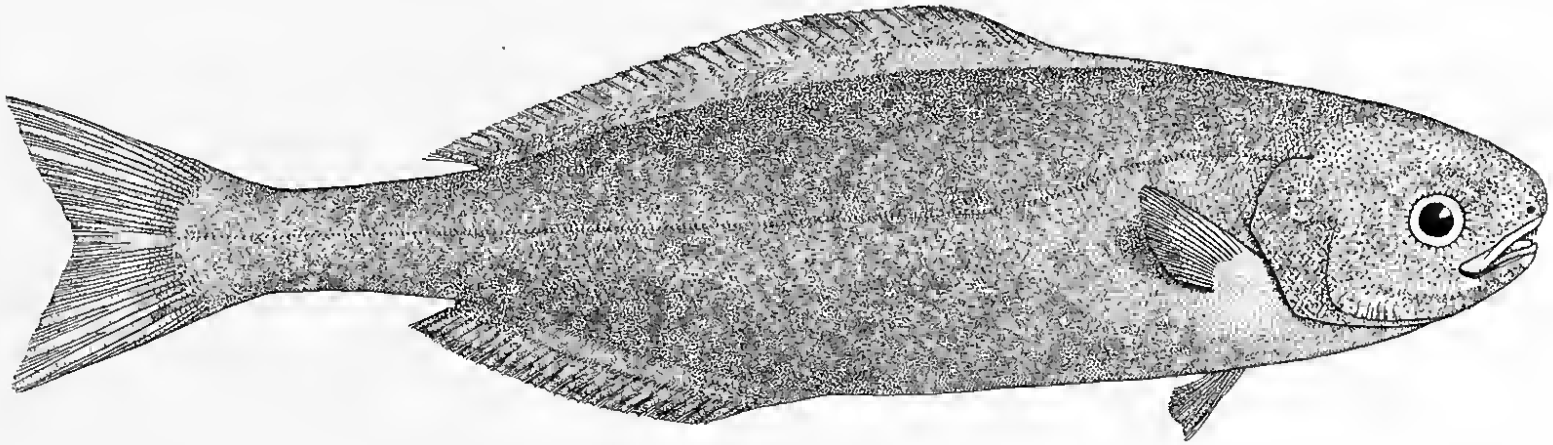
D. 45. A. 30.

A single specimen of this fish, 21 in. (520 mm.) long, came ashore at Polperro, on the south coast of Cornwall, in 1859. This specimen remains unique. It is in the British Museum Collection, and has suffered badly from indifferent stuffing and long exposure to the sun and the public, and no description or figure is likely to be anything but misleading. In its present condition it appears to differ from the last species in the more elongated form, the larger number of dorsal and anal fin-rays, and the shorter curve of the lateral line. We follow Regan in provisionally retaining it as a distinct species. It is possible that Couch's figure may correctly delineate its proportions, but the analogy of better-known species renders this far from certain, and even improbable.

* The evidence of the most recently killed examples which have come under our notice suggests that the dark colour, usual *post-mortem*, may in life be to some extent replaced, by control of the chromatophores, by a pale turquoise blue.



LIRUS MEDUSOPHAGUS × $\frac{2}{3}$



CENTROLOPHUS NIGER × $\frac{1}{5}$

APPENDIX, No. VI.

A NORWEGIAN METHOD OF OYSTER CULTURE.

PREFACE.

By kind permission of Dr. Alfred Wollebaek, of the Norwegian Fisheries Society, I am able to include in this Report translations of three papers which are eminently worthy the attention of Irish oyster growers.

The "pools" in which culture is carried on in Norway appear to be comparable to the "crumpawns" which are such a common feature of our Western coast line.

The very general success which has attended the Norwegian work contrasts favourably with the results, so far as they are known to me, of purely artificial enclosures; but, as the two systems seem never to have been carried on side by side, it would be unwise to conclude that the natural character of the pond is the most weighty factor. The Norwegian Society, however, obviously attach importance, in the selection of a site, to evidences of former natural production.

Other conditions, physical and biological, being, in so far as they have been ascertained, equal, Dr. Wollebaek is able to show that for successful spatting in the "pools" a summer water-temperature of 20° C. (68° F.) is necessary. So high a temperature would, I think, be very seldom reached in this country; but on the other hand the mean temperature of a western crumpawn would probably be found to be higher than that of a Norwegian "pool." If this be the case (which I am not in a position to affirm) the longer period of moderate warmth might have an effect on the generative organs of oysters equal to that of the shorter periods of higher temperature which obtain in the Norwegian pools. It is at least certain that the water temperature of our natural beds not infrequently suffices for a heavy fall of spat, a fact which would seem to justify experiment on the Norwegian system even without much prospect of commanding a temperature of 68° F.

It is evident that the system involves constant attention, and as no apparently suitable site presents itself at any of the centres of the Department's work I see no prospect of being able in the near future to undertake experimental work on these lines. I believe, however, that the Department would gladly assist an experiment by any person who can command the local conditions which appear to be most suitable for the purpose.

In brief, as may be inferred from Dr. Wollebaek's observations, a suitable site would seem to be offered by a crumpawn (i.) having an outlet so narrow that it could be controlled by a sluice at small expenditure, (ii.) sheltered from the prevailing winds by steep cliffs, so

that the water-temperature may not be unduly affected by evaporation, and the oyster baskets may not be liable to be upset by wave motion, (iii.) exposed, as far as is compatible with the last condition, to the greatest heat of the sun.

If such a site he at present to some extent naturally productive, or hear evidence of having been so in the past, the chances of success would of course be increased. E. W. L. H.

The translations which follow were made by Miss Laura Stephens.

I.

OYSTER CULTURE.

Directions issued by the Society for the Encouragement of the Norwegian Fisheries:

(*From the Norwegian Fishery News, No.* 1, 1900.)

For the space of twenty years, during which the Society for the Promotion of Norwegian Fisheries has now heen at work, it has steadfastly directed its attention to oyster culture, and tried to discover ways and means whereby the production of that wholesome hut costly comestible may be increased.

It is intended in the present article to tell in a short space of the experience hitherto acquired, and to give an account of the methods which are hest to adopt, and which will lead to the object in view; namely to make our home oyster culture into a regular and remunerative industry. It may, however, be mentioned that the experience gained applies for the most part to the west coast and that—hitherto at any rate—no one dared to say with certainty in how far the advice here given may also be applicable to other parts of the country.

Here on the west coast there are several localities celebrated from olden times for excellent oysters, of which hy way of example we shall name Sulen, Gulen, Lindaas and Hafrsfjord. When such good oysters come from these places we cannot be far from the trutb in saying that the reason of this lies in the fact that the food conditions in the water in those places are particularly favourable to the thriving and growth of oysters. In Lindaashave, where there is a very large land-locked hasin connected with the open fjord by several very narrow waterways, the temperature in summer is always somewhat higher than in the open sea outside, and that gives a very natural explanation of the excellent nourishment conditions which cause the oysters here to grow more rapidly and to be fatter than in the open sea. Of similar, though smaller, places there are, moreover, a multitude to be found here in the west. Unfortunately, it has not yet been possihle to obtain the necessary belp towards getting a thorough scientific investigation of the food-stuffs contained in the water in these places made, so as to show more clearly that the explanation here given is the correct one.

But in these good oyster-grounds, the stock has heen considerahly diminished. Disease among the oysters has in all likelihood contributed to this result, and it is also possible that the numberless enemies of the

oyster were present in larger numbers in some years than in others, and that this has done them harm; but the essential reason for the decrease in the stock is doubtless this, that the consumption in former times was much too large in proportion to the production.

For a number of years, therefore, oysters have been a rare and costly article, and there is no hope that the proportion will be altered so long as the supply of stock is dependent on natural production in the open sea. It must, however, be said that the natural production is very uncertain. *Before oyster spat can live and establish itself, the water must have a temperature, at the time when the planting out usually takes place, as a rule from June to September, of* 20° *C.* (68° *F.*) *at least, and it has been shown—at least during the past twenty years—that this can take place each year.* That the oysters have established themselves will be shown by the change from a free-swimming larva to a true oyster, which is then hardy.

A rational oyster industry cannot, judging by our experience, be created in this way *solely* by the help of natural production. If we are exclusively dependent on this, we shall find that we cannot annually dredge up from the banks any moderately certain quantity of oysters. *We must, therefore, seek by another method to procure the necessary number of young oysters for planting*, and this may be easily accomplished from the so-called spat pools.

As instances of such pools I shall name the Oyster-creek Pool, the Tysnaes Oyster Company's Pool in Espevig and the Selo and Humlevaags Pools in Sulen. In these pools the temperature is very high, and the fall of spat may be almost regarded as annual. The Tysnaes Oyster Company has in this way, since the beginning of its career in 1885, only had two years without a fall of spat, and the average annual production of spat in the Company's pools has been about one million. It is intended to put a number of similar pools into working order, by degrees, as they are required, in many places which have not hitherto been utilised, and by this means to command a good and reliable source whence young oysters can be obtained for planting out in nearly unlimited quantities.

The removal of the young oysters from the pools for planting out takes place generally from the middle of April and for some time after that, and the oysters are then nearly a year old. The object in view is to transport the oysters from the pools to the fattening grounds at a time when the temperature in the pools and in the sea is as little different as possible. This will usually be the case all the spring till the beginning of May. For the temperature in the pools rises very rapidly in summer, and should the young oysters be transferred from the high temperature there to other places where there is a lower degree of warmth, a large number of them will pine away and die. The Tysnaes Oyster Company's oysters when taken up were formerly laid out to be reared on natural banks on the bottom of the sea. It was found that this method was hampered with great difficulties about keeping the bottom in some measure clean and defending the oysters from their many enemies, of which the star-fish is the chief. This showed that oysters cannot properly thrive in a wild state. Raising the oysters too, which was there performed with the ordinary oyster-dredge, was comparatively troublesome. On this account, for the past few years, it has been the custom to stretch ropes across narrow sounds and little creeks from one shore to the other. From the ropes are suspended flat square baskets, with bottoms of wire netting, in which the oysters are placed

to be reared. In these baskets, which can easily be hoisted up to be cleaned and examined, it is easy to keep the oysters protected from their enemies and at the same time to get hold of the oysters when they are to be taken up for sale.

And this is the method which the Directorate, with the knowledge they have acquired in the past, directs to be followed.

The production of oyster fry should take place in pools and the rearing of them in baskets suspended in places suitable for the purpose.

We must, however, warn our readers that such rearing of oysters cannot be straightway commenced in places other than those where there formerly was a good oyster-bank and where consequently there is reason to suppose that favourable natural food conditions are present.

In this way, many oyster pools (spat pools) were formerly carried on, for it might, with tolerable certainty, be reckoned that the amount of oysters required would be supplied by them. From the Tysnaes Oyster Company such yearling oysters can practically always be purchased for ½ öre each,* and in such an excellent rearing ground as Lindaasbasin, oysters may be reckoned on to attain a saleable size when from four to five years old.

It is desirable that persons obliged to follow the oyster industry should not start out with elaborate apparatus, before sufficient experience has been acquired, but still one should not begin with less than 10,000 brood. A proper test does not imply greater expense than may be easily met by anyone. The baskets generally used are of the above kind, and cost about 1*s.* 1½*d.* each. In each basket from 300 to 400 yearling fry may be placed, but the number must be lessened as the oysters grow. At the end of the third year, when the oysters are three years old, there ought to be only about 100 of them in each basket. The number of baskets must be increased in the same proportion. From 25 to 30 baskets will be sufficient for 10,000 yearling fry ; and in like manner for the same number of three years old oysters, about 100 baskets will be required.

As to the wire on which the baskets are suspended, No. 3 or No. 4 is generally used, according to the length and to the weight which is to be put on it. Between the baskets there ought to be a little space of from ½ to 1 metre. The rope costs about 5 öre the metre (about 1¼*d.* per fathom).

There must always be a certain amount of mortality among the oysters. We cannot therefore reckon on having 10,000 saleable oysters from 10,000 fry. The mortality will naturally depend in a high degree upon careful tending and accurate supervision. If, however, we get 30 to 40 per cent. of saleable oysters from 10,000 fry, we must regard the result, in the light of previous experience, as satisfactory.

All further information and all necessary assistance may be obtained on application to the Society's office. All persons who think they have places suitable for oyster culture can have them examined and reported on from time to time by the Society's officers. As a rule too, in the first year a small contribution towards the purchase of oyster fry may be reckoned on ; thus, to persons who themselves purchase 10,000 oysters for 50 kroner,† 50 kroner will be given for the purchase of 10,000 more.

And here we leave the matter. It is not of course impossible that, in the course of time, other and better methods may be found for the

* About 6¼*d.* per 100. † About £2 16*s.* 3*d.*

rearing of oysters than by the help of the baskets as now used, but it is by the practice of this method that the Onaes and Maraas Oyster Company, which has been supported for several years by the Society, has attained good and economically favourable results, and it ought therefore to be safest, in any case for the present, to hold to the existing method. It is the Society's firm conviction that oyster culture may become a great benefit to the farms along our coast districts, in which there are places suitable to the industry. On such farms there will always be leisure time when the oysters can be supervised and looked after, and there need be no doubt but that the undertaking can be developed, at all events, into a very useful and productive domestic industry. There need be no anxiety on the score of over-production. Even with a large increase in production, within the next few years, Bergen, Stavanger, and Haugesund will be able to consume all, or the majority of them, and though the means of transit are deficient in many respects, it is not worse than sending the oysters elsewhere. A certain number are thus exported every year to Christiania and Sweden. And when the Bergen railway is finished, as it ought to be in a couple of years, such an extensive market will be opened up with Norway and Sweden that facility will be given for the disposal of all that can be produced.

II.

ON METHODS OF COLLECTING AND REARING OYSTER FRY.

BY

ALF. WOLLEBAEK,

Zoologist to the "Society for the Encouragement of the Norwegian Fisheries."

(*From the Norwegian Fishery News, No.* 5, 1902.)

The interest in oyster culture, thanks to several successful experiments, has grown steadily, and the number of new oyster-rearing grounds grows year by year. It may therefore be helpful to give some more detailed description of the methods of that culture as now carried on everywhere here in the West.

The work on artificial oyster culture falls into two main categories.

i. Collecting the fry (in spat pools), and

ii. Rearing (on fattening grounds).

In the following pages we shall try to give a description of the methods of collection and rearing for the information of those desirous of commencing oyster breeding. It is beyond the scope of this article to give any account of the historical development of the method. We shall only describe it as now carried on.

i.—COLLECTING THE FRY IN SPAT POOLS.

In the form of larvæ, oysters swim about freely in the water for a certain length of time. When the larval development is at an end, they attach themselves to some stable object and begin their life as reproductive creatures.

For many years past it has been a well-known fact that oysters, in certain specially warm pools along the coast, were capable of producing an enormous amount of spat, and that first and foremost it was necessary to collect this in a satisfactory manner.

As the bottom of the so-called spat pools is, for the most part, covered with soft mud, a large quantity of the spat was lost where care was not taken to provide sufficient stationary objects to which it might attach itself. This is now done by hanging out bundles of twigs on iron wires stretched from one shore of the pool to the other.

These bundles of twigs are usually known by the name of Collectors.

The twigs may be bound together in various ways; either

1. Simply fastened together in bundles (like a broom) as shown in Fig. 1, or

2. The twigs are bound together side by side to an iron rod, or screwed together between two wooden laths so that they form a sort of flat wall. Fig. 2.

The material most frequently used is birch twigs. As the spat sooner or later must be plucked off the collectors, birch twigs have this great advantage that the bark is easily loosened and comes away with the creatures, whereby we avoid having to separate them, which moreover is not easily done, as spat generally fastens itself very firmly to the object to which it has once attached itself.

The thickness of the twigs is generally that of common broom-twigs; they ought to be cut in winter when the sap is at rest; *newly cut they are of no use*, for the spat will not settle on them.

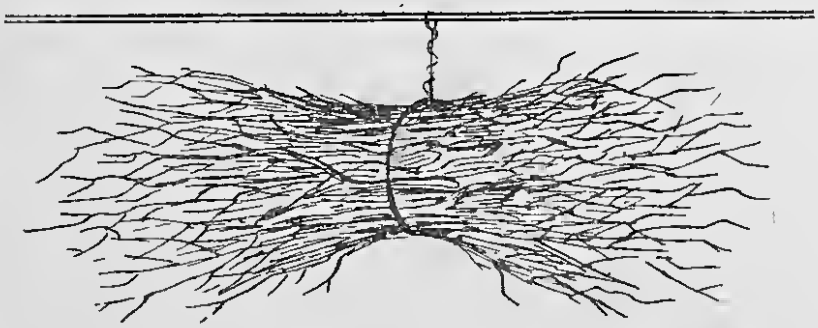


Fig. 1.

The twig-bundle collector shown in Fig. 1. is from 1 to 2 metres long. In order to sink the collectors, it is well to fasten a stone in among the twigs in the bundle.

The flat twig collector (Fig. 2) is 1 or 2 metres long and ¾ metre to 1 metre high.

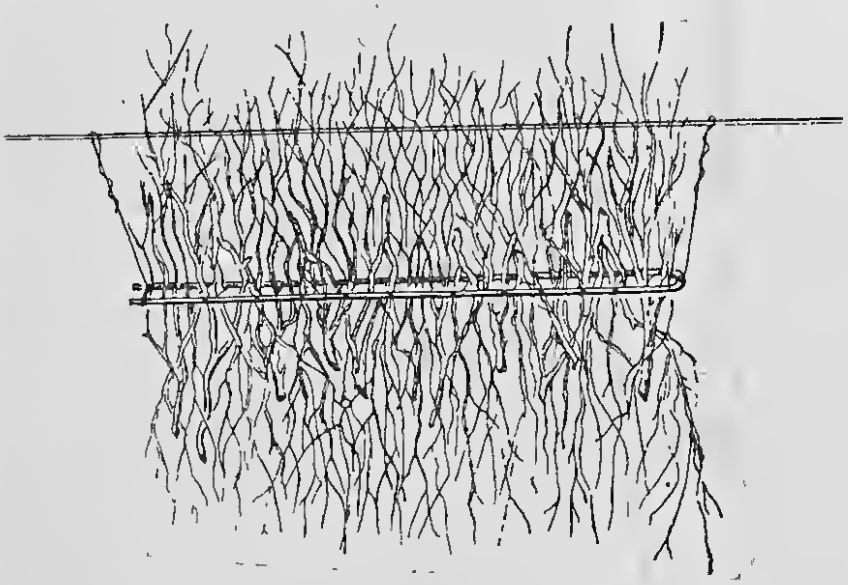


Fig. 2.

The iron rods to which the twigs are attached in the latter sort of collector are usually bent round (like a hair pin) so that they enclose twigs on both sides. (See sketch). The twigs are fastened on with steel wire or spun yarn.

Formerly, instead of iron rods, wooden laths were used (now no longer employed in pools where ship-worms [*Teredo navalis*] occur) in which case sinkers had to be fitted to the collectors, for which purpose tiles were usually employed. If iron rods be used, the collectors as a rule are heavy enough without any extra sinkers.

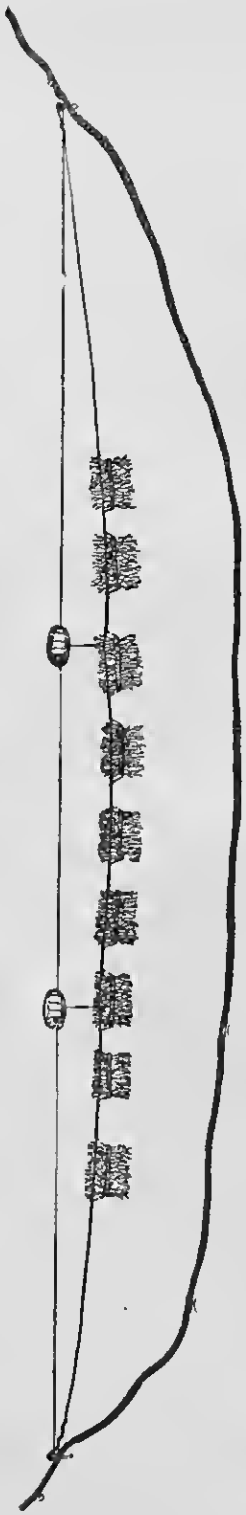


Fig. 3. Section of pool, showing spat-collectors in place.

The arrangement in Fig. 3 shows how the collectors are placed in the water. The iron wire to which the collectors are suspended ought not to be less than No. 4 gauge ($\frac{1}{4}$-inch), and must be galvanized. The lines stretch from one side of the pond to the other and are strained sufficiently tightly to suspend the collectors a couple of metres below the surface of the water. Between the collectors and the bottom there ought to be at least a couple of metres.

If the pool be surrounded by rocks where there are no suitable natural points for attaching the lines, a hole must be bored in the rock close down by the water line and an eye-bolt driven in. The eye-bolt should be of $\frac{3}{4}$-inch iron, about 6 inches in length, with the eye 2 inches in diameter.

Kegs must be used to keep the collectors suspended at the right depth. The size of these depends on the length of the line, on how tightly it is strained, and how large a number of collectors are suspended on it. Some use paraffin barrels, others commonly half-barrels. The distance between the barrels also depends upon the weight on the line, the size of the float, &c. If paraffin barrels are attached at every tenth fathom, then we shall be able to hang out as many collectors as the line can accommodate.

The collectors should be hung out in the spring. The largest quantity of spat is deposited on them in the summer. In general, the fry is left quiet till the following spring, April or May. The raising of the collectors with the fry attached is usually accomplished from a boat or from a raft specially constructed for the purpose.

Transport cases (Fig. 4), in which fry when detached can be placed and despatched, should be placed temporarily, before sending off to the fattening grounds, in the sea and not in the pools. The cases float upon the surface, and as the surface water of such pools contains as a rule a small proportion of salt, the fry would be injured if left lying there for any length of time.

The transport case is about 1 metre long, by about 52 cm. broad, by about 21 cm. high, ($39 \times 20\frac{1}{2} \times 8\frac{1}{4}$ inches) fitted with a cover and floor of $\frac{1}{2}$-inch wire netting (see Fig. 6).

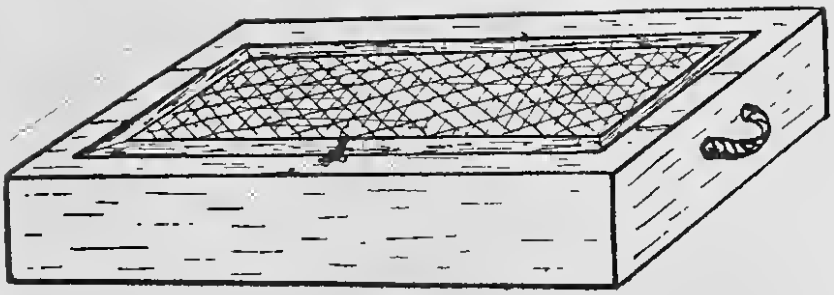


Fig. 4.

ii.—Rearing Fry on Fattening Grounds.

The method which is now almost exclusively adopted and is therefore here described in greatest detail, is the system of *rearing in baskets* suspended in the same way as described in the above paragraph in regard to spat collectors.

Baskets should be always made of galvanized wire netting. Fry, which is fit to be set out to fatten when it is nearly one year old, is generally about $1\frac{1}{16}$ in. in size. A good number are larger and a good number smaller. For this reason we must, at first, use baskets of different sized mesh. The finer meshed the netting we have to use, the dearer will be the basket.

We shall use three different sizes of mesh, $\frac{3}{4}$, $\frac{1}{2}$, and $\frac{3}{8}$-in., the first two of ordinary hexagonal mesh, the last of square mesh.

Fig. 5 gives a sketch of a finished basket. It is very easily made. From wire netting, 90 cm. (3 ft.) wide, cut off a square piece of 90 by 90 cm. Between the meshes along each side, about 7 cm. (3 in.) from the edge, push a piece of No. 6 ($\frac{1}{5}$-inch) iron wire about the length of the sides of the net.

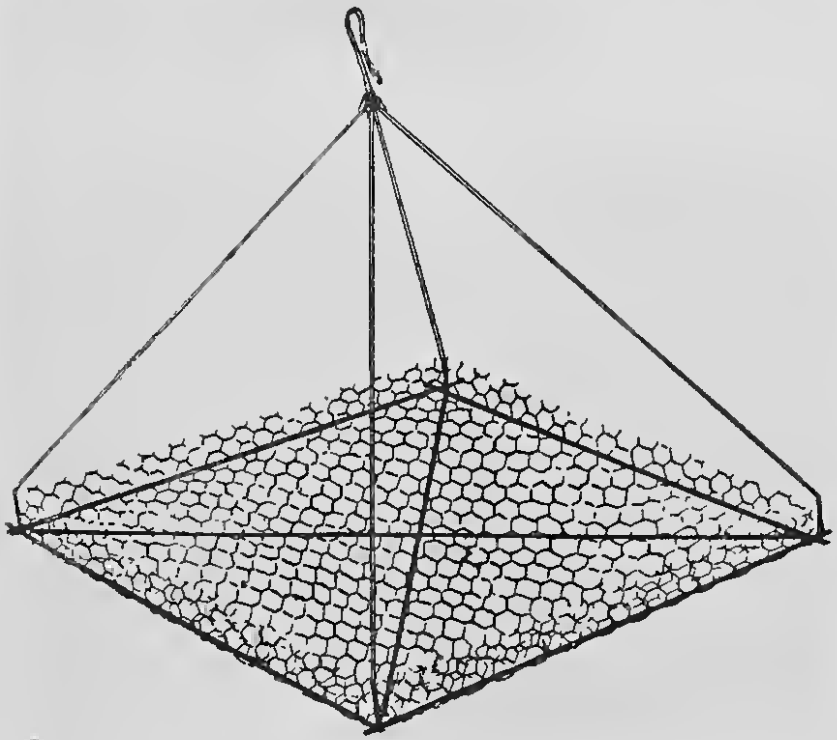


Fig 5.

Instead of the iron rod along each side, two pieces bent to an angle may be used, as seen in Fig. 6. By this device the baskets are strengthened, but are somewhat more tedious to make, in that two of the sides (the uppermost and lowest in the sketch) must be lashed to the net, preferably with galvanized iron wire No. 18 or 19, which is most easily done after the edges of the wire netting are bent up and the bottom has taken the form seen in the drawing of the finished basket.

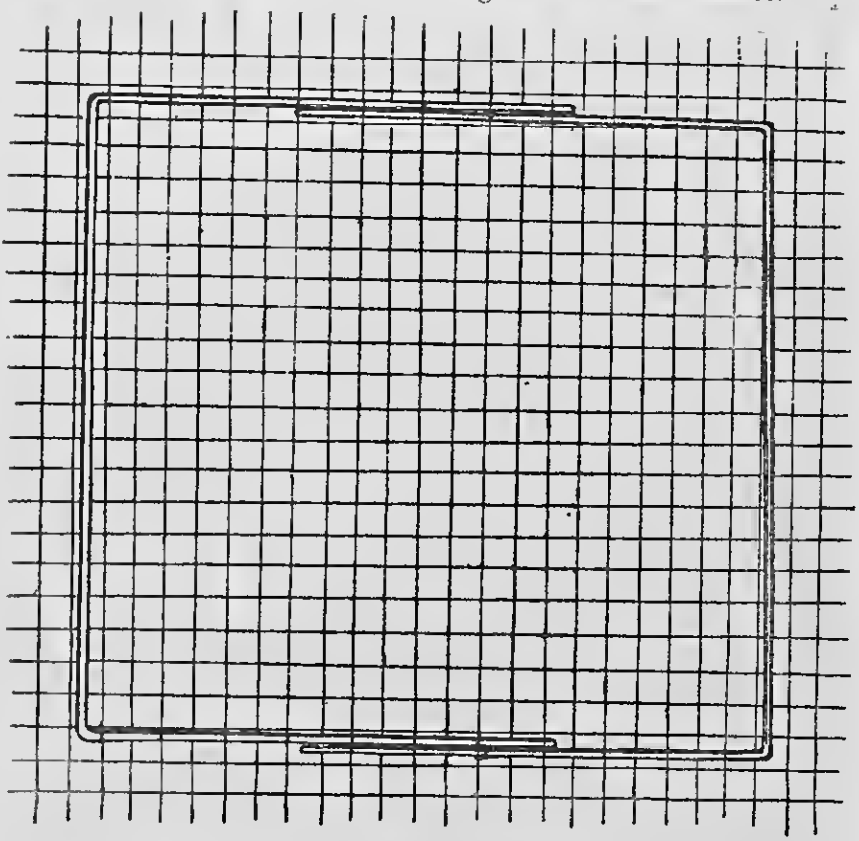


Fig. 6.

The arms of the basket are also of $\frac{1}{5}$-inch iron wire, No. 6. Take two iron rods, each as long as three times the distance between the corners of the bottom, push each of them through the net between the opposite corners of the bottom, so that a long straight piece of the iron rod projects through from each side, bend these free ends of the rods upwards, and fasten them together at the top. Here, finally, attach a hook on which to hang the basket.

The cost of such a finished basket of $\frac{1}{2}$-inch wire netting will come to about a kronor*, not including the cost of labour.

Since baskets of $\frac{3}{8}$-inch square-mesh netting come more than double as dear,† and as the fry which is scarcely a year old is very rarely mixed with individuals of such small size as to require such a fine mesh, we may, to avoid the expense of the fine-meshed baskets, make shift with one of large mesh, if a piece of fine netting be placed in the bottom of it. Still we do need, on the other hand, a small number of

* With iron rod at about $\frac{1}{4}d.$, and wire netting at about $10\frac{3}{4}$d. per yard. A kronor is worth about 1*s.* $1\frac{1}{2}d.$ A metre (39·37 inches) bears much the same relation to a yard as a kronor to a shilling.

† Netting at about 2*s.* per yard (2*s.* 3*d.* a metre).

fine-meshed baskets, for the small size of the fry enables a considerable portion of it to be placed at the same time in one single basket. According as the fry grows, it must be distributed in several baskets of large mesh. From this it follows that the baskets of finest mesh are superfluous and need not be taken into use, except to make provision for sending out young fry to the fattening grounds. A fine-meshed basket of $\frac{3}{8}$-inch net may, therefore, be counted on to do its work for a couple of years longer than those of coarse mesh, which are in use the entire year. A basket of from $\frac{3}{4}$ to $\frac{1}{2}$-inch net has been calculated by experience to be serviceable for from three to four years, scarcely longer, which corresponds to the number of years which fry in the generality of our feeding-grounds need in order to attain a saleable size. On this, as is easily understood, depends to a considerable degree the vitality of the Basket System here treated of. If we must for two lots provide, so to speak, a " new house " for one and the same brood of oysters, many of the advantages will be lost, and the labour will be augmented to a high degree.

As was said just now, the baskets are suspended, on the same plan as the twig collectors, a couple of metres from the surface on No. 4 gauge iron wires stretched from one shore to the other. Kegs, as described in the last section, are used. At the same time there may, in isolated cases, because of the ice in winter, be difficulties connected with the use of floats. Instead of floats to bear up the ropes with the baskets at the right depth, trestles may be also used, standing firmly in the ground and with lines resting athwart the trestles. This arrangement, however, entails the avoidance as much as possible of hoisting up the ropes to see how the baskets are going on, as is always done when floats are used.

There is difficulty, too, about getting the ropes back again into the cross-pieces on the trestles, and one must be always prepared for the baskets getting into disorder. A wire rope with floats can always be fitted for each basket. Strings are fastened firmly to the hook of each basket, and small pieces of wood may be used as floats. These should be used solely for supporting the wire rope.

A distance of about 10 fathoms between the trestles will be sufficient to take 8 or 10 baskets in between. A very great distance is not advisable, for the ropes may thereby be caused to sag, which makes the baskets slide together and hang crooked, the fry consequently collecting in a heap in one side of the basket, the growth being thereby impeded and the shell acquiring a bad shape.

When floats are not provided for each single basket, the ropes on which the baskets hang must be hauled up to see how the stock is going on. The best implement for this is a rope armed with an iron hook made of $\frac{3}{4}$-inch iron, from 6 to 8 inches long.

As already stated, the fry is taken up from the spat pool when from $\frac{3}{4}$ to 1 year old, that is in April or May, and is immediately set out in the place where it is to be fed.

The following may be taken as a general rule :—

Of $\frac{3}{4}$ to 1 year old oysters, from 3 to 400 to a basket,

Of 3 to 4 year old oysters, about 100 to a basket.

Instead of plucking the fry off the collectors and carrying it to the fattening grounds in cases, it is also sometimes the custom to hang out the twigs together with the fry in the place where it is to feed, and only after a year, when the fry has grown and the twigs begin to be brittle is the fry picked off and laid in baskets. This method is very practicable when there are no worms in the twigs.

The method of oyster culture described in the foregoing pages, and which has shown itself, after a reasonable period, to have taken root in this country, requires absolutely careful attention and intelligent rational management. If the creatures under culture be not carefully looked after, but left to themselves, we may just as well give up the whole thing at once—it will only entail loss. However practical oyster culture on the method here described may seem to be, it will need very little ill-management before the scale-pans oscillate, and the whole result turns out to be loss instead of profit. It is not sufficient to lay the oysters in baskets, to hang the latter in a pool, and so leave them to themselves. We must regularly inspect the fry, keep the baskets free from *confervoideæ* (filamentous weeds): see that the fry has sufficient room in the baskets; distribute them among different baskets when they grow, so that they may never lie one upon the other; watch that the baskets do not hang crooked, whereby the fry might be caused to slide together in a heap, which may also easily happen in places where the current is strong. We must likewise look after the floats, obviously to see if they are sufficient support. When the fry begins to grow it increases remarkably in weight. If the fry be allowed to sink down to a muddy bottom, it is soon all up with them.

In order to give an idea of the expenditure necessary in rearing oyster fry according to the methods described above, we give below the following statement of the amount which must be spent in making 10,000 fry saleable, assuming that they attain a saleable size after fattening for three years:—

	Kr.
Labour, . .	about 360.00
Fry (buying price), .	50–100.00
Baskets, ropes, &c., .	150.00
Transport, packing, &c., .	25.00
Total, . .	635.00 kr. (about £12).*

If we calculate at the rate of 10 öre each (or 11*s.* 3*d.* per 100 oysters), the return on 10,000 oysters is 1,000 crowns (about £56), and comparing with this the sum of expenses given in the above statement, which is certainly not reckoned too low,† the nett profit works out as 365 crowns (about £21).

But only in the very rarest cases can we reckon on obtaining from 10,000 fry 10,000 saleable oysters. It follows, therefore, from what has gone before that a person, in order to be successful at the business, must not lose, in the course of the three years which oysters need to attain a saleable size (the period on which the above calculation is based), more than 36½ per cent., that is, he must not lose on an average more than 1,200 per year during the three years of his 10,000 oysters.

But, at the same time, we must remember that oyster culture in this country is carried on essentially as a domestic industry, and thus the 360 crowns entered in the statement above for "labour" in rearing 10,000 oysters go into the oyster grower's own pocket.

The long experience in the domain of oyster culture of Herr Assistent Ole Eriksens has been of the greatest assistance to me in the preparation of the above pages.

* At 13·5 pence to the kronor.

† Based on the highest buying price of fry.

III.

A COMMUNICATION ON OYSTER CULTURE.

BY

ALF. WOLLEBAEK.

PLATES VI. TO XV.

(*From the Norwegian Fishery News, No.* 9, 1901.)

NORTHERN BERGENHUIS DISTRICT.

(GULEN AND SULEN.)

In Gulen and Sulen there were formerly, and may still be found in isolated spots, several varieties of natural oysters. But the artificial culture of oysters in those districts has only within the past few years developed into a really important industry.

On the broken coast line, with so many land-locked bays, sounds and pools (Poller), new spots may always be found where attempts are being made, and with good results, to cultivate oysters. Scarcely any stretch of our coast line can show such an abundance of pools as Sulen and Gulen, and the interesting thing about it is that in nearly all these natural oysters are to be found, the remains of former days, when there was abundance of them. In these sheltered pools, with abundance of food material, they have been able to hold their ground, accumulate and spread, in spite of the fatal invasion of such places by human beings. Almost everywhere, before people came to these districts, so runs the tale, there were, 20 or 30 years ago, plenty of oysters, but in the seventies people travelling about took up, partly with the help of divers, all that they could find. But in the pools and land-locked basins, where a higher temperature accelerates spat production, we find that it still continues.

Such pools and basins, which formerly were able to nourish a plentiful supply of oysters (which has diminished, not by natural decay, but by economic exploitation), it has first and foremost been important to utilise once more for the rearing of oyster-spat,* on the presumption that the conditions for this have not diminished, but have only lain fallow. In addition, various other places, appearing to offer similar favourable conditions, have now been taken into use in the service of oyster culture, though the guidance found in the natural occurrence of oysters was lacking. It must not be held that oysters cannot thrive in places where they do not naturally occur. The oyster, like every other animal, has a certain power of acclimatisation, that is, when it is worth such culture, and this is now the question and will always be one of the chief problems to be dealt with.

In all the places here in Norway where oyster culture is prosecuted we shall find a sort of universal rule that, in those places where fattening is carried on, large seed-production only exceptionally occurs; and conversely in places where one can

* The author here refers readers to the paper (p. 78) in which the method of culture is described.

gather millions of spat, we shall very rarely be able to get them fat so quickly (if indeed we should ever succeed in fattening them at all) as at the proper fattening places. People are thus beginning to regard "Fattening Pools" and fattening places as distinct from "Spat Pools." The difference between them consists, as far as I know, exclusively in temperature. The uncommonly high temperature attainable in breeding pools produces an abundance of spat.

In Sulen as well as in Gulen pools of both varieties are already to be found in full work.

In the unusually warm summer weather this year the temperature, even in several of the fattening pools, rose so high that the oysters placed there for fattening spawned; even in places where there were only two-year old oysters a spat deposit took place.

While spawn in breeding pools in the middle of last September was already $1\frac{1}{16}$-in.* in size, the spawn in the fattening pools at the same time, attached to the shell of the mother oyster, was for the most part very small, seldom more than 1 cm. (about $\frac{2}{5}$-in.) in diameter. The cause of this I think may be, in the first place, the late spawning which took place in consequence of a late introduction of a high temperature into the fattening pools, and the youth of the parent oysters, which in the fattening pools were only from two to three years old; and the spawning time for such young individuals, as for so many other animals, generally arrives somewhat later than in the case of older individuals. As to the temperature, there were at the end of May in the fattening pools between 11° and 16° C. (52° and 61° F.), in the majority of places from 12° to 14° C. (54° to 57° F.). In the Kverne spat pool there were, on the other hand, no less than $20\frac{1}{2}$° C. (69° F.) throughout the whole period. Later on through the summer the temperature in isolated fattening places rose even to 22° or 25° C. (72° or 77° F.). A high temperature in fattening places lasted longer this year after the harvest than in former years when no spat planting was carried on.

We think that there can be scarcely any special advantage to be gained by allowing the oysters spread out in the pools to spawn. Such a process, at all events, takes place at the expense of the fattening. The fattening pools where spawning took place were just the most land-locked and the most completely cut off from the sea. I believe that a control of the temperature and a regulation of the influx of fresh sea water in the summer months is, on the other hand, advisable, provided it is not specially desired to obtain spawn from the oysters spread out to fatten, in order to avoid the expense of purchasing it. Moreover, I believe that such a method of obtaining spawn, at a time when it can be bought so cheaply from special breeding pools, is of but little advantage. It will take place to the detriment of the fattening, not only because of the spawning process itself, but also because of over-population; the land-locked pools in proportion to their small dimensions can be easily sown beforehand. And, finally, I must advise great caution in the sowing of a large quantity of spat in one and the same pool.

We shall, in the following pages, give a glance at the various places in Sulen and Gulen where oyster culture is already in full swing, and, further (in Part ii.), we shall enumerate the places where it is proposed that new schemes shall be started in the coming year.

* The author, throughout this paper, uses the Norwegian halfpenny—5 öre, as a standard of size. Its diameter is about $1\frac{1}{16}$-in.

i.

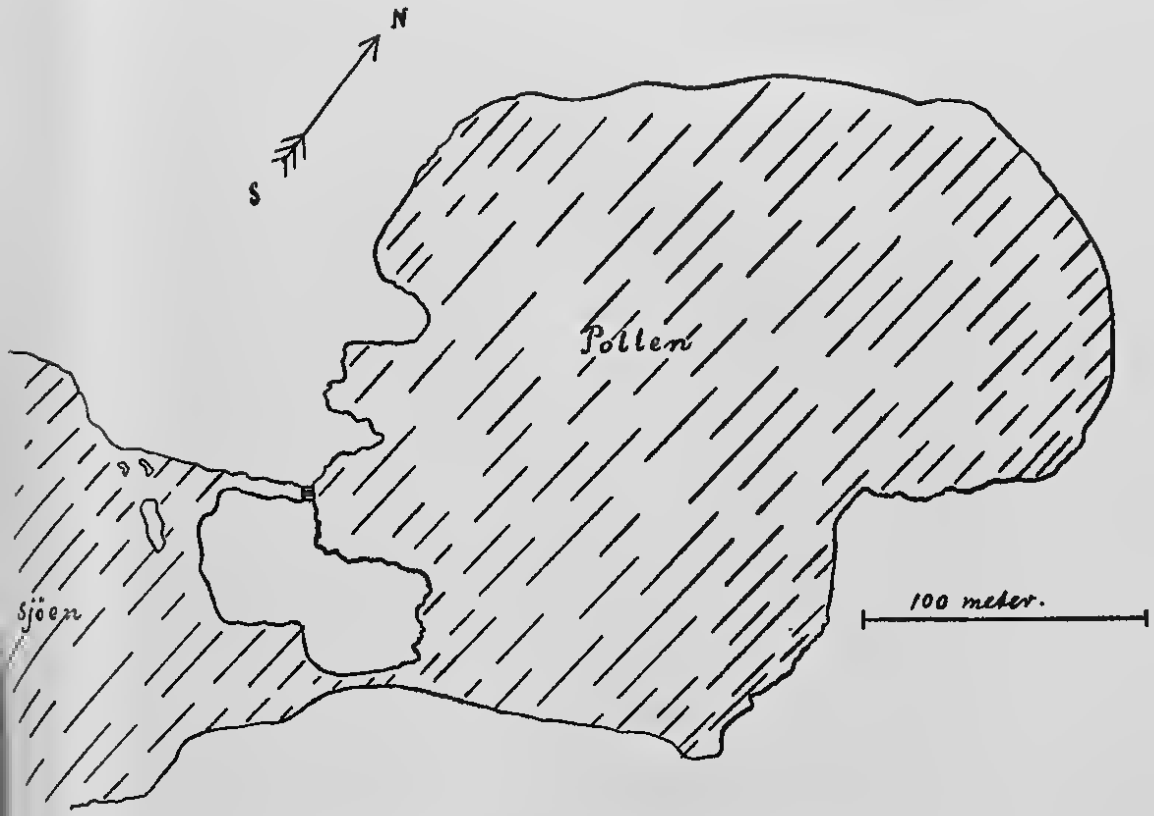
POOLS WHERE OYSTER CULTURE IS ALREADY IN FULL SWING.

(*a*) GULEN.

1.—KVERNE POOL (Spat Pool).

Our illustration (Plate VI.), from a photograph taken from a high hill-top right over the pool, gives an opportunity never hitherto afforded, and shows us a real oyster pool and its general appearance. The pool is about 300 metres long. Its greatest depth is 4½ m.,* and it is of tolerably even depth. The entrance is very narrow, only a few metres in breadth, and is dry when the tide falls; the pool stands in connection with the sea.

This pool was first made use of in 1899. An iron rope is stretched over the pool on which a number of haskets with mother oysters and a number of spat collectors are suspended. Here only bundles of hirch branches are used for this purpose, not as now in the Espevik pool where they use flat collectors made of twigs, consisting of twigs laid side hy side and fastened to a thin iron bar. The bunches of twigs are thickly covered with spat, and so likewise are the baskets in which the parent oysters were suspended. Other oyster fry is found clinging to stones on the bottom along the sides of the pool. An abundance of oysters was likewise sown in 1900



KVERNE POOL.

* m. = metre, *i.e.* about 39 inches.

On nearer examination of the cliff sides and stones along the sides of the pool it was found that here are attached a number of very large old oysters, very much more numerous than the owner had any notion of. These were found to be of different sizes, a sign that the spat depositing had taken place with tolerable regularity, even before the pool had been taken into use as an "artificial" breeding place. Thus the expense of suspending mother oysters might apparently have been saved. At the same time it would have been possible to collect a very large supply of spat, provided that several twig collectors had been suspended in various other parts of the pool, instead of as now when they are only hung on a single rope. This year, therefore, two new ropes have been stretched, on which 90 twig bundles are hung. The result is that all the collectors are very thickly covered. A large number of the year's fry had already, in the middle of September, reached a size of $1\frac{1}{16}$-in.

Ship worm (*Teredo navalis*) is not to be found in the pool.

Instead of posts to support the ropes trestles are employed, which stand firmly on the bottom. The ice in the early spring destroyed the posts.

Already on 29th May in the present year (1901) there was a temperature of 20·5° C. (69° F.), in a depth of two metres. A lower temperature than this could not be found before the latter half of September.

2.—NYHAMMER POOL (Fattening Pool).

The Nyhammer Pool, on Hiso Island, may, as a fattening place, be favourably compared with any other in the country. In Sulen and Gulen, at any rate, it hold the first place. Situated as it is just outside the owner's door, he can exercise constant supervision and oversight of the oysters placed there for fattening.

The pool is about 300 metres in length and breadth. Its greatest depth is 8 m. From 6 m. depth in the north end of the pool, the bottom slopes evenly to 8 m. depth in the southern end. The bottom is, for the most part, covered with smooth mud. The pool stands connected with the sea by a sound about 50 ells broad.

In the spring of 1900 the sound was barred by a wall, though not a high one, so that the sea overflowed it. During the year about 10,000 fry were planted, which were spatted in the Kverne pool during the preceding year. The greatest proportion of the fry is not plucked off the collectors, but the whole bundle with the fry is placed in the pool. Fifteen baskets of gathered fry were planted. Part of the fry was so small that it slipped through the mesbes of the baskets. To remedy this it is necessary to procure more expensive, finer-meshed wire netting, pieces of which should be laid in the bottoms of the baskets.

It is only after the lapse of four months, in which time the fry has grown considerably, that the greater part of it is plucked off on twigs and distributed in 25 baskets. After this masses of the

fry are distributed among several baskets in such a way that it never lies close together, but every single creature is free by itself.

1901. On 28th April in this year about 30,000 fry from the Kverne pool were placed here. The fry was treated in the same manner as in the preceding year. This fry, too, has thriven remarkably, and already at the end of May has grown considerably. The shell has acquired an edge of from 1 to 1½ cm. (⅖ to ⅗-in.) in breadth in this one month. The contents were very plump. None have died.

The spat planted last year has likewise grown considerably. None died. Ice lay in the pool from Christmas till the middle of March, but that has apparently had no evil effect. Any particular growth of the fry as regards circumference could not be traced in the course of the winter, but the thickness of the shells, on the other hand, increased quite remarkably.

At harvest time from 9,000 to 10,000 oysters had attained a marketable size. Compare with this the number of oyster fry planted in the spring of 1900.

The temperature of the Nyhammer pool has been throughout the summer kept up to 22° C. (72° F.) (20th Aug.), which for a fattening place was uncommon. The result of this also was that the oysters spawned; numerous small fry were found on the shells of the mother oysters.

By way of comparison with last year, when no spawning took place, the following table of temperatures (C.) is given:—

Date.	Depth in Metres.							
	Surface.	1.	2.	3.	4.	5.	6.	7. Bottom.
1900.								
4 July,	16·	16·	20·	18·	17·	16 3	16·1	15·8° C.
20 July,	15·	15·	16·	17 5	18·	18·	16·	16
25 July,	15·	15·	15·5	16·	16·	17·	17·2	16·
7 August,	15·	15·	18·	17·5	17·	17·	17·	16·
29 August,	15·	15·	15·	15·	16·	16·	16·	15·5
17 September,	12·	12·	–	13·	–	13·5	–	14·5
1901.								
22 May,	12·	12·	12·	11·	10·5	10·	10·	–
30 May, 3 p.m.,	16·6	16 3	14 8	14·2	13·9	13·4	13·2	–
13 June,	14·1	15·7	15 9	15·6	15·35	–	14·5	–
7 July,	16·	18·	19·	20·	20·	18·	16·	–
20 August,	12·	17·	20·	22·	22·	20·	17·	16·
22 September, 7.15 p.m.,	15·8	14·8	13·8	14·2	15·1	–	–	–

3.—TÖNSBERG POOL (Fattening place).

We shall examine the first harvest of last year. In May the pool was already in full swing. 10,000 yearling oysters from Espevik pool on Tysnaes Island were planted on 21st May, together with some fry from the Kverne pool. When the fry was taken up in May from the Espevik pool the temperature in that pool was already fully 20° C. (68° F.). In the Tönsberg pool on the same day when the oysters were planted the temperature was between 12° and 14·5° C. (54° and 58° F.). Before the oysters were laid out in the Tonsberg pool, and after they had been taken up from the Espevik pool, they were left for a time in the open sea. On the 7th June we inspected the oysters which had been planted. They showed unmistakable signs of thriving and growth. No dead oysters were found. The different changes in temperature during which the fry were placed had apparently no injurious influence. With this result a comparison should be made of the attempts to transplant fry from the Espevik pool to Klovning Sound in 1897. The temperature in the Espevik pool when the fry was lifted was 27° C. (81° F.), but in the Klovning Sound when it was planted the temperature was only 19° C. (66° F.). Notwithstanding this, the attempt was very successful, and the fry throve well, and were large and plump.

When the last harvest of the Tönsberg pool was inspected, on 21st September, the development shown was very satisfactory. In the course of the summer months, they had increased so much that the room in the baskets was very limited. The manufacture of several new baskets was therefore put in hand.

Plate IX. shows the average size of the young oysters on 21st September (from a photograph).

In this pool also spawning took place; the size of the new spat was still, at the end of September, scarcely that of a pin's head.

Tönsberg pool is fully as big as the pool in Nyhammer; 5 m. in depth, but the sea only comes in at high tide.

(*b*) SULEN.

1.—HUMLEVAAGS POOL (Spat Place).

The Humlevaags pool was originally a fresh-water pool near the sea, which, by mining and excavating a canal, was connected with the sea. Already in 1895 the work with the pool began. In the first few years nothing further was undertaken. In 1898 the pool gave its first big yield of spat. In 1899 the spawning was likewise successful, whereas in 1900 no spat was laid out owing to faulty management.

1901. The temperature records of 4th June this year show scarcely 18° C. (64° F.) (compare with the spawning pool at Kverne in Gulen) which is the highest found here and was taken at a depth of 1 m., on which account measures were taken to diminish the inflow of the sea. A very abundant crop of spat was sown in the course of the summer, and the fry grew rapidly here, as in the spat pool in Gulen. (It is proposed to arrange the basin at Tungodden as a breeding pool. The work of wall building which had already been begun before last year's harvest was not finished soon enough to admit of the pool being taken into use)

2.—HARDBAKKE POOL (Fattening Place).

A pool about 300 m. long, and about 4 m. broad, but the inlet, which is quite shallow and is dry when the tide retires, is connected with the sea. The depth is 4 m. When the pool in 1899 made its first venture it was planted, chiefly by way of experiment, with 4,000 yearling fry from the Humlevaag pool near by. These grew and throve to a marked degree; already in the next year's harvest a good part of them could be put on the market, though they were only from $2\frac{1}{4}$ to $2\frac{1}{2}$ years old.

In the spring of 1900, a new sowing of 15,000 fry, likewise from the Humlevaag pool, and spawned the previous year, was made. These also showed a fine growth, and were plump and fat.

1901.—4th June. The pool lies a good distance from the house, so its care and supervision in the course of the winter 1900-1901 were not so perfect as desirable. A number of oysters of both ages died. In the majority of baskets space was limited, on which account the work of making new baskets was begun.

There are now, 17th September, 1901, already in the pool 94 baskets, of which 80 contain $2\frac{1}{2}$-years old oysters and 16 those of $3\frac{1}{2}$-years old. A good number of baskets for distributing the fry were finished, but not yet set out. Of the $2\frac{1}{2}$-years old oysters the number amounted to about 15,000, of which at least one-third is now marketable in harvest and winter time. Of the $3\frac{1}{2}$-years old oysters (spread in the pool in 1899) there remained about 1,000. These were uncommonly large, plump, and of excellent quality. We give in Plate X. a photo of a specimen of the $3\frac{1}{2}$-years old oysters. When sown in the spring of 1899 they were about $1\frac{1}{16}$-in. in size.

As a favourable fattening place, the Hardbakke pool may well be compared with the Nyhammer pool in Gulen, but the often difficult nature of the path to it and the distance at which it lies from the house render it impossible that care and supervision should be so frequently exercised as in the case of the Nyhammer pool. A path to the pool has been made this year.

3.—FURREVIK BAY, IN THE HAGEFIORD (Fattening Place).

(See the Annual Report, 1900, of the Society for the Encouragement of the Norwegian Fisheries.)

A small bay of sinuous shape, 18 to 20 m. deep; in the inner part, in which oysters are hung out for fattening, it is some metres deeper, so that here, in the same way as in the "Poller," can be found the same kind of mud bottom, but not by any means to the same extent as in them. Baskets with fry are hung at a depth of 2 m. under the surface, at a spot where the total depth is 8 m.

The place was first taken into use in the spring of last year. On 16th May, 1,000 two-years old oysters were placed here, and about 10,000 one-year old oysters from Humlevaag. These throve and grew well in the course of the summer. But after the harvest some of them began to die, especially those which were two years old.

In the winter, 1900-1901, a number of them were also swept away. In those baskets where the greatest number of individuals were there was the highest rate of mortality, and the rate of growth

and percentage of survivors were lowest. In the baskets where there were only from 60 to 80 oysters growth and development were the most satisfactory. Afterwards, in the early spring of 1901, some more died, nor were we free from mortality in the summer months. In the end of last September there was left a total of 2,600 oysters, $2\frac{1}{2}$ and $3\frac{1}{2}$ years old. The growth of the survivors was altogether excellent, and the fish were of good quality, with a fresh salty taste.

In the bottom of the bay, where oysters were suspended, the temperature in summer (29th July) attained 21° C. (70° F.). Compare the temperatures and bottom formations on p. 100.

4.—VAULEN IN HAGEFIORD (Fattening Place).

From Vaulen pool a number of natural oysters have been sold every year for the past score of years. First in 1899 the pool was taken into use as a fattening place for oysters which had floated into it. 150,000 of these were placed in the Humlevaag pool. Already at harvest time in 1900 a good number of these were so large as to be fit to be sent to market.

When the place was visited in last September the condition and growth of the stock was good; some of it was fit for sale.

5.—TVERANGER POOL.

Here there were formerly, and are, moreover, still to be found a number of natural oysters. The pool formerly yielded a good revenue, but in the past 20 or 30 years the owner, by way of precaution and not because the pool was lying waste, has not sold any oysters.

The pool is uncommonly warmly situated, being surrounded by high hills. The depth is 6 metres. The bottom is formed of plentiful, smooth, black mud.

Small fry of $1\frac{1}{16}$-in. in diameter were last year found attached to stones along the hill sides.

The building of a wall of tree trunks to regulate the inrush of the tide is now completed. In the spring the spat which floats in will be attended to.

6.—POOLS IN NAESÖFIORD.

For 20 or 30 years back up to five or six barrels of oysters were annually fished here. From the end of the seventies the pool remained untouched for six years. From that time till now oysters have annually been taken from the pool to the value of from 200 to 300, or perhaps 400 kroner (about £10 to £20). Of late years there were taken from one side of the pool alone six, eight, or even ten fjaering (one fjaering=from 60 to 70 large oysters) of oysters. These are cele-

brated for their flavour. They are paid for at first hand at the rate of 18 or 20 öre apiece ($1\frac{3}{4}d.$ to $2d.$). They are very large, not infrequently over a hand's breadth in size. Thirty or forty years ago oysters were to be found here in great abundance, but of poor quality. The inlet from the sea was at that time reconstructed on such a scale that the sea only at very high tide sent fresh water into the pool.

At the end of the seventies the inlet was cleared out so that the sea at high tide rushed into the pool. Since that time the quality of the oysters has been excellent.

The pool has always been used as a fattening place for spat which has floated in. It is four fathoms deep. The bottom is the same as in the last-mentioned pool.

ii.

RECENT EXPERIMENTS IN OYSTER PLANTATION IN SULEN AND GULEN.

In the course of a journey in Sulen and Gulen, undertaken in the beginning of last May, various new places were found where investigations into temperature, bottom, and plankton gave very much the same results as in the places where oyster culture was already going on with very good results. In the oyster planting experiments which were subsequently made, partly on the newly discovered spots, the character of the ground formation was specially observed.

Characteristic of all oyster pools is the composition of the bottom, which consists, more or less, of smooth black mud. In the sea outside the pool such mud will never be found. Here it gets washed away and will only be able to collect in deeper water. The majority of the pools are never over 8 or 10 metres deep, but the mud, notwithstanding, is able to collect, for the barrier separating the pool from the sea only resists the rise of the tide in the highest parts. The mud appears to contain an enormous quantity of microscopic organisms, chiefly diatoms, which are partly resting spores and partly bottom forms. These form the oyster's chief nourishment. In the oyster's digestive organs exactly the same forms may be found as in the mud on the bottom. But, we may ask, how do oysters, hung out in baskets often several metres from the bottom, get fat on bottom-living diatoms? An explanation of this may be found in the "blooming time" (swarm stage) of the diatoms, in which they come up into the plankton, even into the topmost layer of water. As the swarm stage does not occur at the same season for all varieties, the food material will be different at different times.

At the same time as oysters were hung out to fatten in places with diatomaceous mud bottoms some were also suspended in a bay on the open sea where the ground formation was quite different, but where the average summer temperature was not very different from that of the other places where oysters were hung out to fatten.

Among the many new places the following have heen chosen for experimental purposes:—

IN SULEN—

1. Kjeile Pool (Krakhelle Sound).
2. Flöite Pool, at the end of Björnefiord.
3. Raake Pool (in Raake Sound).
4. Southern Larvig Pool (in Raake Sound).
5. Northern Larvig Pool (in Raake Sound).

IN GULEN—

6. Glavaer (near Skjaergehavn); and
7. Harbakke Bay (by Stensund), Sulen, which is not enclosed by any barrier from the open sea.

At none of these places has any damming or any wall huilding been undertaken for the purpose of regulating the inflow of the sea into the pools.

The temperature taken in the new test places in the middle of June was on an average 1° to 2° C. (about $1\frac{3}{4}$ to $3\frac{1}{4}$° F.) colder than in the places where oyster fry had already been suspended to fatten, but almost 1° warmer than in the sea outside. This difference of temperature is not to he takcn as playing a very important part, provided there be a sufficient supply of food material.

The 3,000 fry or thereabouts with which experiments were made, distributed among the above-mentioned places, consisted partly of fry from Kverne pool and partly from Espevik. The fry from Kverne pool, before heing placed in the new heds, had lain in haskets in the Nyhammer pool for a month and a half and the Espevik fry for one month in basins at the biological station there.

Plate VII. shows specimens of the different sizes of the fry planted out there.

1.—KJEILE POOL.

From the sea we come first into a shallow pool; from this a very narrow inlet leads to the inner pool, which is very large, fully 18 m. deep We found not a few natural oysters in this pool. From twelve to fifteen years ago a numher were taken up hy divers (the Wergeland Company), but since that none.

Samples of plankton were found to be rich, and the temperature was between 14° C. (57° F.) on the surface and 12·5° C. ($54\frac{1}{2}$° F.) on the hottom in the heginning of June. In the middle of June (13th) we planted in this place, where the depth was 8 metres, 435 fry, distributed in four baskets. The temperature was about the same as in the heginning of the month.

On the 14th August the place was visited hy the Society's Assistant, Herr Ole Eriksen, who hrought home the four specimens from which the photograph, Plate XI., was taken. The growth of the fry from 13th June to 14th August is evident by a comparison with Plate VII. The specimens brought home were of medium size. Growth took place evenly in all haskets. None died.

2.—FLÖITE POOL (Inner Part).

Depth 4½ to 5 metres. The bottom is composed of smooth mud. The temperature on 6th June was between 15° and 13° C. (59° and 55° F.). Shells of oysters and other molluscs were found at the inlet to the pool. Large, living, natural oysters were found on the cliff sides in the outer part of the pool.

Two baskets, 150 young oysters in each, were placed here on 15th June. The temperature on that day from surface to bottom was not more than 11·55° C. (53° F.).

Specimens taken up on the 17th September are given in their natural size on Plate XII. This, as well as the other plates, is a representation, in the natural size, of specimens of average dimensions to which the planted out fry attained.

3.—RAAKE POOL.

A very large, land-locked basin, 8 m. deep. A narrow inlet, which at low tide is only ½ m. deep. Natural oysters are found here. The temperature on 3rd June was 14·2° C. (57·5° F.) (surf.), 11·65° C. (53° F.) (4 m.), and in the sea outside 11·56°. The bottom formation is abundant smooth mud, containing masses of bottom-living diatoms. The 300 fry placed here on 14th June (partly from Espevik and partly from Kverne pool) showed remarkable development, when we visited the place on 17th September. The fish were very plump and fat. None were dead.

Plate XIII., fig. 2, shows the size of the fry on 17th September.

4.—SOUTHERN LARVIG POOL.

This is also a very large basin with an inlet of from five to six boats' lengths in breadth and a depth of a couple of metres. The pool's greatest depth was 6 metres. Temperature and bottom formation the same as in Raake pool. Here also natural oysters were found. Here, as well as in the Raake and Northern Larvig pools, there must formerly have been a number of natural oysters, which have been carried off by voracious fishes. Two baskets with altogether about 300 fry were placed here on the 14th June. The depth in the place where the baskets were hung was hardly 3 m. A few handfuls of fry were then thrown into the shallow water at a spot where the bottom was covered with sand, broken debris and the shells of molluscs. These, as well as the fry hung out in the baskets, grew remarkably during the summer, and became fat and plump. Those on the bottom had regularly attached themselves and had risen up on their edges. None were dead.

5.—NORTHERN LARVIG POOL.

A large basin, also with a broad but shallow inlet of hardly 1 m. in depth. When the tide goes out very far the inlet is dry. The

pool is 8 m. deep. Numbers of natural oysters are found along the cliff sides and in the pools, some were only a few inches below low water mark. The shells were fine and well formed, the contents fat. Plankton specimens were found to he rich, and the composition of the bottom was the same as for the above-mentioned pools. 200 fry were placed here in two baskets on 14th June. On Plate XIII., fig. 1, we give a photograph of a specimen after a growth of three months. None of the fry laid out were dead.

6.—GLAVAER (in Gulen).

A very small, well-sheltered pool, with a land-locked bay in front of it; 4 m. deep. The temperature on 15th June at a depth of 4 m. was 15·5° C. (60° F.) and at 1m. in depth 12·5° C. (54½° F.). Two baskets with the remains of the fry which had been brought (about 430 altogether) for the most part (four-fifths) only very small, were planted on 15th June. Even the very smallest scarcely 10 öre* in size, had grown considerably in the course of the summer. Our picture, Plate XIV., from specimens taken up on 21st September, gives the average size. No fry were dead.

By way of comparison with the development of oyster fry in these six last-named places, where bottom formation, temperature, &c., were of a tolerably uniform character, we placed three or four baskets in a bay by Hardehakke (near Stensund in Sulen), where the sea has free admittance without any barriers, and where the bottom is for the most part overgrown with "eel-grass" (mill-seed, Zostera). The temperature in this bay was something the same as in the above-mentioned pools as well in the middle of June, when the fry was planted, as on 17th September, when we again visited the place. The shells of the young oysters had attained the same dimensions as in other places, but the contents were very thin; they were evidently suffering from liver enlargement. But still none were dead.

The bottom at this place contained no such quantity of diatoms as in the pools containing smooth mud.

Shell development this year has been unusual, in the older as well as in the newer places enumerated above. But when the contents have everywhere not increased in the same degree it was doubtless owing to the composition of the food, which has not been equally excellent in all places, which fact is, moreover, explained by the different bottom formation of the various places, since a bottom rich in resting spores and diatoms is able to produce a much richer plankton than one which is poor in them.

As I shall, on a subsequent occasion, be able to give a more accurate account of the plankton investigations, I shall not now go any more closely into this question. I must only mention an interesting circumstance, namely, that the bulk of the diatoms which occurred in our oyster pools are very nearly related to the well-known diatom *Navicula fusiformis*, var. *ostrearia*, which constitutes the oyster's chief nourishment in the celebrated pools at Marennes, whither large quantities of fry from different places in France (Arcachon, la Tremblade, &c.) are sent to be made plump

* A ten öre piece is rather larger than a penny.

and green, which result is obtained through the medium of that variety of the diatom.*

In all the six new places in Sulen and Gulen where experiments are being arranged, it is the owner's intention to go on with oyster culture, to purchase fry and plant it out in the coming spring. Several of the new pools are very large, and have several owners, but not only those owners on whose land the experiments are being made are thinking of beginning oyster culture, but also many other land owners have asked that similar experiments should be made on their property, or that help should be given them so that they may begin oyster culture immediately in the spring on a large scale. The two to four baskets containing from 100 to 150 young oysters each, which were suspended in the various places, were handed over to the owner as his property on condition that he took their care on himself. By stretching ropes, driving posts, manufacture of baskets, and suspension of fry, the owner was at the same time enabled to learn the whole method of procedure for his future assistance in practical work, should he decide to continue oyster culture—as indeed they all have decided, because of the favourable results of the experiments. In the baskets placed in the water owners will have models according to which they can subsequently manufacture similar ones.

When we saw in September what we had planted in the spring we were pleased to observe with what care the work was everywhere carried out and supervised. In this fact we see reason to believe that the future oyster culture in these places will yield good results.

CONCLUDING REMARKS.

Breeding pools, even in the first year after they have been taken into use, may be in a position to produce a cash income, as the fry from them can be sold when scarcely a year old. In fattening pools, on the other hand, an income cannot be reckoned on, at least before a year and a half have elapsed, for oysters set out for fattening never attain to marketable size in a shorter period.

Not till harvest time, therefore, will the majority of fattening places in the districts in question begin to yield an income, and it is our hope at the end of the season to furnish a statistical summary of the income and expenditure for each pool. In order to be able to obtain absolutely accurate statistics, a journal was sent

* The well-known French oysters of Marennes have a distinctly green appearance. The green colour is found chiefly in the gills, and is due to the colouring matter called *Marenin*, which is found in the cellular juices of *Navicula fusiformis* var. *ostrearia*. The green colouration simply consists in the fact that the oysters imbibe *Marenin* from the cellular juices of this variety of diatom. *Marenin* is a blue colouring matter of which, moreover, very little is known. As the natural colour of the oyster's gills is light brownish or golden, the blue colour gives them a green tinge, more or less pronounced, according as the natural tint was a fainter or stronger golden. *Navicula fusiformis* var. *ostrearia* is the one known diatom containing a blue colour. All other varieties are exclusively brown. To this may most likely be ascribed the brown colour of our oysters.

round in the spring to the different pool owners, with a request that they would fill up income and expenditure under the heads provided. This request has everywhere been most kindly complied with. Oyster pools which already in two years yielded an income (fry sold in the spring) produced in that time the expenditure many times over, but it is clear that the oyster pool's fate stands or falls by the degree of success attending the obtaining of young fry.

As the owners of oyster pools are, as a rule, owners of small farms, whose income in cash is not great, it has been difficult, for several reasons, to supply ready money for starting oyster culture. It has, on the other hand, been one of the Society's tasks to grant pecuniary support as far as funds admitted, and likewise the necessary help and guidance.

The necessary help and guidance (by the building of walls, purchase and placing of fry, preparation of baskets, &c.) has hitherto been looked after by the Society's Secretary and Assistant. Since, however, Herr Joh. C. V. Fleischer, whose work in the domain of oyster culture has been so beneficial to Gulen and Sulen, has now retired from his position as Secretary of the Society, it is here my very pleasant duty to express to him my thanks for his constant readiness, since my connection with the Society, to assist me with advice and information.

Bergen, *October*, 1901.

TITLES OF PLATES.

VI. Kverne Pool in Gulen.

VII. 2½-years old oysters, fattened in the Nyhammer pool for a year and a half. Specimens of the fry planted out on 1st June, 1901. Natural size.

VIII. 1½-years old oysters, fattened in the Nyhammer pool for half a year.

IX. Fourteen months old oysters, planted 21st May, 1901, taken up 21st September, 1901. Tönsberg pool.

X. 3½-years old oysters, fattened in Hardbakke pool for two and a half years.

XI. Thirteen months old oysters. 1, 2. Fry from Kverne pool. 3, 4. Fry from Espevik pool. Planted 13th June, 1901, taken up 14th August, 1901. Kjeile pool.

XII. Fourteen months old oysters. Planted 15th June, 1901. taken up 16th September, 1901. Flöite pool.

XIII. Fourteen months old oysters. Planted out 14th June, 1901, taken up 17th September, 1901. Fig. 1, Northern Larvig pool. Fig. 2, Raake pool.

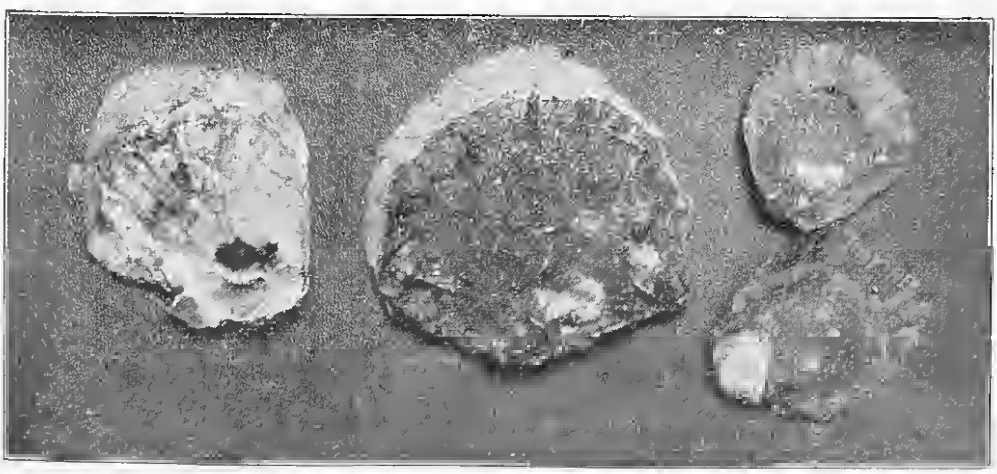
XIV. Fourteen months old oysters. Planted out 15th June, 1901, taken up 21st September, 1901. Glavaer.

XV. Map of Gulen and Sulen.

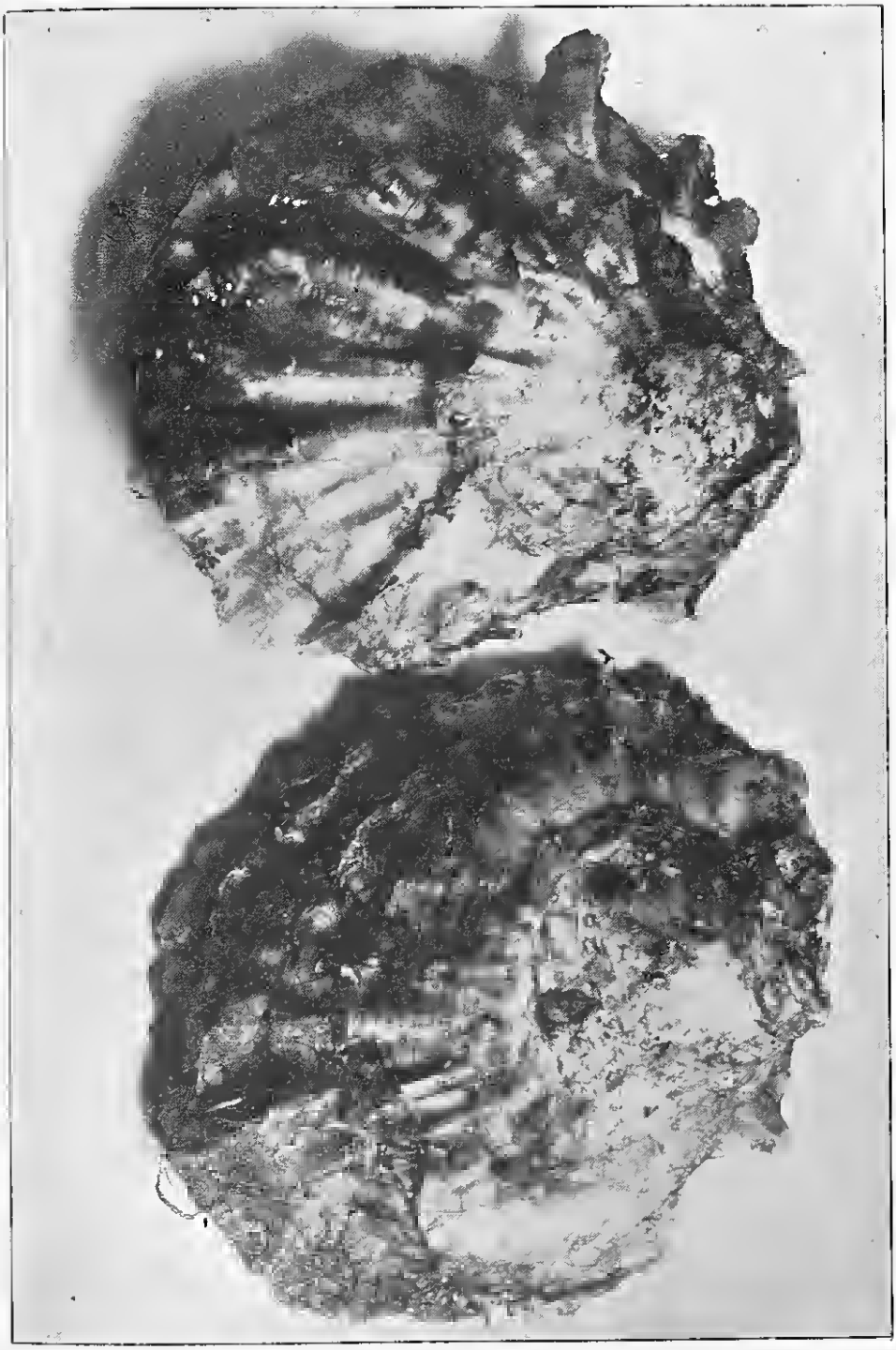
Plate VI.

KVERNE POOL.

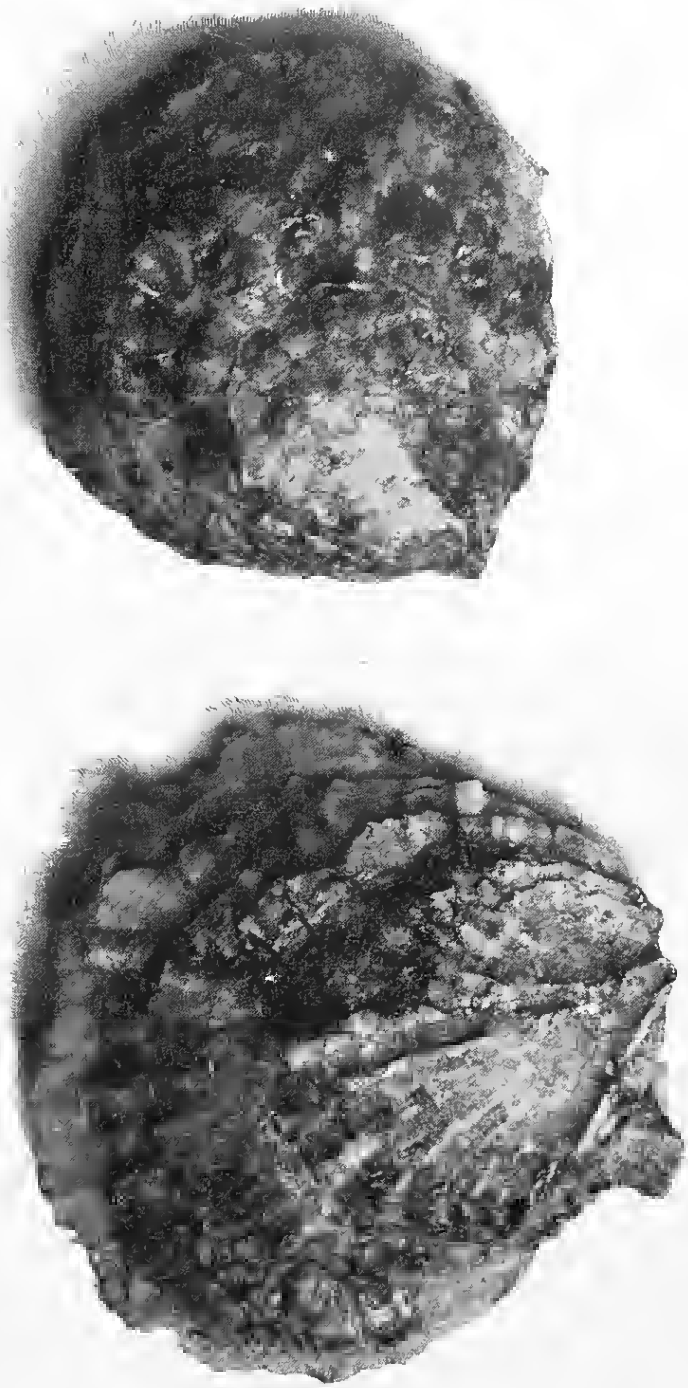
TWO-AND-A-HALF YEARS OYSTER, FATTENED IN THE NYHAMMER POOL FOR A YEAR AND-A HALF.



SPECIMENS OF THE FRY PLANTED OUT ON 1ST JUNE, 1901. NATURAL SIZE.



ONE-AND-A-HALF YEARS OYSTERS, FATTENED IN THE NYHAMMER POOL FOR HALF A YEAR.



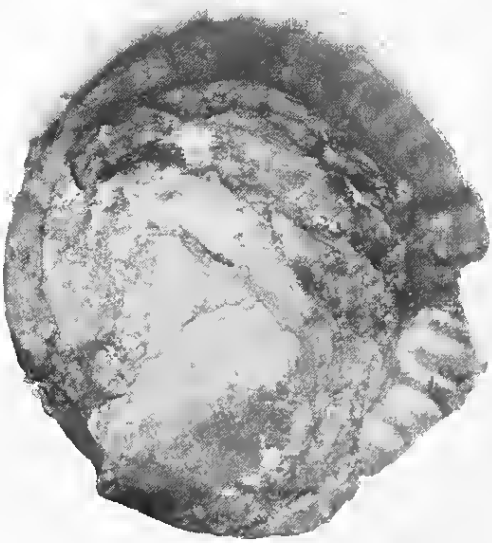
FOURTEEN MONTHS OYSTERS, PLANTED 21ST MAY, 1901, TAKEN UP 21ST SEPTEMBER, 1901. TONSBERG POOL.

THREE-AND-A-HALF YEARS OYSTERS, FATTENED IN HARDBAKKE POOL FOR TWO-AND-A-HALF YEARS.

1

2

3.



4.

THIRTEEN MONTHS OYSTERS.

1 AND 2—FRY FROM KVERNE POOL.

3 AND 4—FRY FROM ESPEVIK POOL.

PLANTED 13TH JUNE, 1901, TAKEN UP 14TH AUGUST, 1901. KJEILE POOL.

FOURTEEN MONTHS OYSTERS. PLANTED 15TH JUNE, 1901, TAKEN UP 16TH SEPTEMBER, 1901. FLOITE POOL.

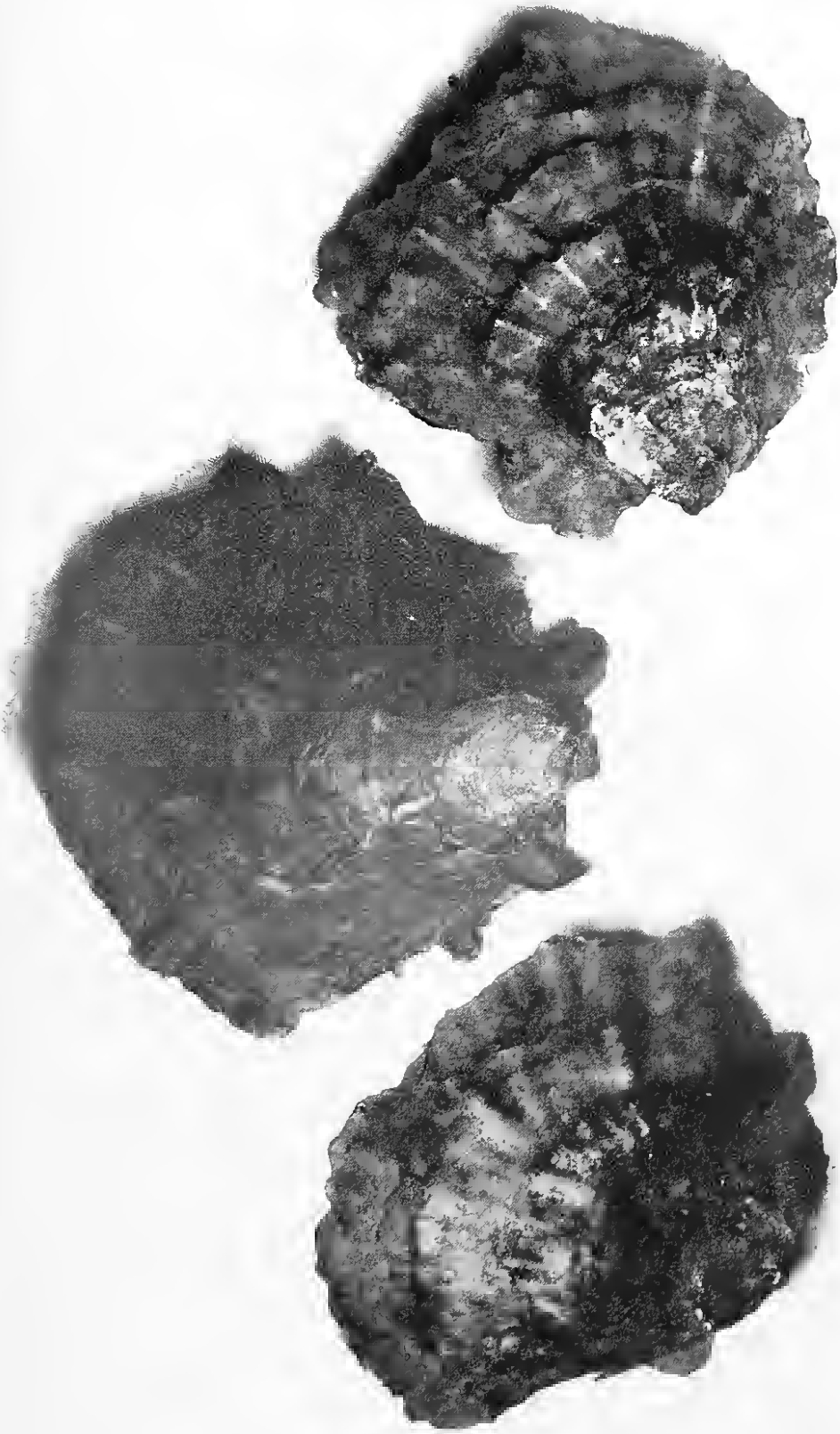
1

2

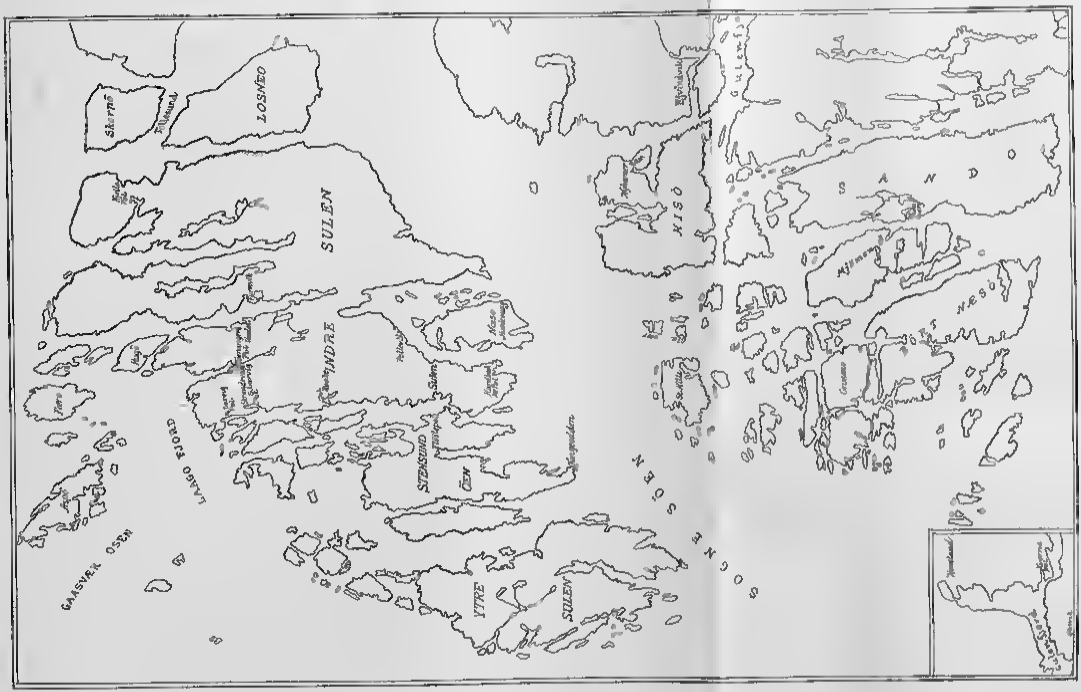
FOURTEEN MONTHS OYSTERS. PLANTED 14TH JUNE, 1901, TAKEN UP 17TH SEPTEMBER, 1901.

FIG. 1.—NORTH LARVIG POOL.

FIG. 2.—RAAKE POOL.



FOURTEEN MONTHS OYSTERS. PLANTED OUT 15TH JUNE, 1901, TAKEN UP 21ST SEPTEMBER, 1901. GLAVAER



MAP OF GULEN AND SULEN

APPENDIX, No. VII.

RECORD OF THE COPEPODA TAKEN ON THE MACKEREL FISHING GROUNDS OFF CLEGGAN, CO. GALWAY, IN 1901.

BY

G. P. FARRAN, B.A.

PLATES XVI AND XVII.

i. Table of Distribution and Relative Abundance.

ii. List of the Copepods taken, with Notes.

iii. Description of New Species.

iv. Copepods as Fish Food.

i.—TABLE OF DISTRIBUTION AND RELATIVE ABUNDANCE.

The symbols used in the table to express the relative abundance of copepods are :—A. = abundant = *ca.* 60 %; C. = common = *ca.* 30 %; M. = moderate = *ca.* 20 %; F. = few = *ca.* 10 %; V.F. = very few = *ca.* 4%. The figure (1) indicates that only one specimen was met with. The total bulk of the catch, and the quantity of copepods taken are expressed in cubic centimetres, and in some cases the actual number of copepods is given in brackets.

[TABLES.

TABLE OF DISTRIBUTION AND

DATE.	FEBRUARY.			MARCH.							
	26th.			11th.		14th.			19th.		
STATION NO	XIII. ML			XIV. ML		XV. ML			XVI. ML		
	A	B	C	A	B	A	B	C	A	B	C
Hour,	6.50 pm.			6.20 p.m.		4.0 a.m.			6.30 p.m.		
Time fishing,	10 min.			10 min.		—			10 min.		
Distance from mainland,	10 miles.			½ mile.		8 miles.			6½ miles.		
Depth of water,	42 f.			14 f.		37 f.			36 f.		
Depth of net,	1	20	40	1	14	1	18	36	1	17	35
Total catch in cc.,	·4	·75	·75	–	1·25	1	2·25	4·5	·5	1·5	2·75
Catch of Copepods,	(82)	(317)	(600)	(35)	(160)	(214)	(1113)	(3700) = 3 cc	(256)	(1260) = 1 cc	(2130) = 2·8 cc
Calanus finmarchicus,	–	VF	VF	C	A	C	A	A	A	C	C
Eucalanus elongatus,	–	–	–	–	–	–	–	–	–	–	–
Paracal. parvus,	VF	F	F	F	F	M	F	VF	M	M	M
Calocal. styliremis,	–	–	–	–	–	–	–	–	–	–	–
Clausocal. arcuicornis,	(1)	–	–	–	–	–	VF	(1)	–	–	–
Ctenocal. vanus,	–	–	–	–	–	–	–	–	–	–	–
Pseudocal. elongatus,	(1)	F	C	M	M	F	C	M	C	C	C
Bradyidius armatus,	–	–	(1)	–	–	–	–	–	–	–	–
Scolecithrix pygmæa,	–	–	–	–	–	–	–	–	–	–	–
Centropages typicus,	–	–	–	–	–	(1)	–	(1)	(1)	–	–
Centropages hamatus,	–	–	–	F	VF	–	–	–	–	–	–
Isias clavipes,	–	–	–	F	VF	–	–	VF	–	–	VF
Temora longicornis,	–	(1)	–	–	–	(1)	(1)	VF	–	(1)	VF
Metridia lucens,	A	A	C	–	–	F	VF	F	VF	F	M
Candacia pectinata,	–	–	–	–	–	–	–	–	–	–	–
Anomalocera patersoni,	–	–	–	–	–	–	–	–	–	–	–
Parapontella brevicornis,	–	–	–	VF	VF	–	–	–	–	–	–
Acartia clausi,	–	VF	VF	(1)	F	VF	VF	VF	VF	VF	VF
Acartia discaudata,	–	–	–	–	–	–	–	–	–	(1)	–
Oithona similis,	VF	F	VF	F	F	M	VF	VF	F	VF	VF
Oithona plumifera,	–	–	(1)	–	–	–	–	VF	–	–	–
Oithona nana,	–	–	–	–	–	–	–	–	–	–	–
Oncæa conifera,	–	–	–	–	–	–	–	–	–	–	–
Oncæa media,	–	–	–	–	–	–	–	–	–	–	–
Corycæus anglicus,	–	–	–	–	–	–	–	–	–	–	–
Longipedia coronata,	–	–	–	–	(1)	–	–	–	–	–	–
Dactylopus stromii,	–	–	–	–	–	–	–	–	–	–	–
Dactylopus tisboides,	–	–	–	–	–	–	–	–	–	–	–
Alteutha crenulata,	–	–	–	–	–	–	–	–	–	–	–
Diosaccus tenuicornis,	–	–	–	–	–	–	–	–	–	–	–
Thalestris clausii,	–	–	–	–	–	–	–	–	–	–	–
Thalestris rufocincta,	–	–	–	–	–	–	–	–	–	–	–
Thalestris helgolandica,	–	–	–	–	–	–	–	–	–	–	–
Thalestris harpactoides,	–	–	–	–	–	–	–	–	–	–	–
Thalestris longimana,	–	–	–	(1)	–	–	–	–	–	–	–
Idya furcata,	–	–	–	–	–	–	–	–	–	–	–
Harpacticus { chelifer, + gracilis, }	–	–	–	–	–	–	–	–	–	–	–
Caligus,	–	–	–	–	–	–	–	–	–	–	–

RELATIVE ABUNDANCE.

APRIL.											DATE. 1901.
1st.			12th.			17th.		19th.			
XXI. M L			XXIII. M L			XXIV. M L		XXV. M L			STATION NO.
A	B	C	A	B	C	A	B	A	B	C	
6.30 p.m.			5.40 p.m.			5.50 p.m.		10.0 p.m.			Hour.
5 min.			10 min.			5 min.		—			Time fishing.
3½ miles.			9½ miles.			1½ miles.		12 miles.			Distance from mainland.
45 f.			50 f.			14 f.		48 f.			Depth of water.
1	20	40	1	25	48	1	14	1	24	47	Depth of net.
2·75	13	30	25	31	35	6·5	11	4·5	5·5	17	Total catch in cc.
2·5	11	20	25	30	33	6	10	4	5	11	Catch of Copepods.
A	A	A	A	A	C	A	A	A	A	A	Calanus finmarchicus.
–	–	–	–	–	–	–	–	–	–	–	Eucalanus elongatus.
VF	VF	VF	VF	VF	VF	F	F	VF	VF	F	Paracal. parvus.
–	–	–	–	–	–	–	–	–	–	–	Calocal. styliremis.
–	–	–	–	VF	–	–	–	–	–	–	Clausocal. arcuicornis.
–	–	–	–	–	–	–	–	–	–	–	Ctenocal. vanus.
F	F	M	VF	VF	A	M	C	M	M	M	Pseudocal. elongatus.
–	–	–	–	–	–	–	–	–	–	–	Bradyidius armatus.
–	–	–	–	–	–	–	(1)	–	–	–	Scolecithrix pygmæa.
–	VF	VF	–	VF	VF	VF	VF	VF	–	VF	Centropages typicus.
–	VF	VF	–	–	–	(1)	–	–	–	(1)	Centropages hamatus.
–	(1)	–	–	–	–	(1)	VF	(1)	–	–	Isias clavipes.
–	VF	VF	(1)	(1)	VF	VF	VF	–	VF	VF	Temora longicornis
(1)	–	VF	–	VF	VF	VF	VF	VF	VF	F	Metridia lucens.
–	–	–	–	–	–	–	–	–	–	–	Candacia pectinata.
–	–	(1)	–	(1)	–	–	–	–	–	–	Anomalocera patersoni.
–	–	–	–	(1)	–	(1)	–	–	–	–	Parapontella brevicornis.
VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	Acartia clausi.
–	(1)	–	–	–	–	–	(1)	–	–	–	Acartia discaudata.
VF	VF	VF	(1)	VF	VF	VF	VF	VF	VF	VF	Oithona similis.
–	–	VF	–	–	–	–	(1)	–	–	–	Oithona plumifera.
–	–	–	–	–	–	–	–	–	–	–	Oithona nana.
–	–	–	–	–	–	–	–	–	–	–	Oncæa conifera.
–	–	–	–	–	–	–	–	–	–	–	Oncæa media.
–	–	(1)	–	–	–	–	–	–	–	–	Corycæus anglicus.
–	–	(1)	–	–	–	–	–	–	–	–	Longipedia coronata.
–	–	–	–	–	–	–	–	–	–	–	Dactylopus stromii.
–	–	–	–	–	–	–	–	–	–	–	Dactylopus tisboides.
–	–	–	–	–	–	–	–	–	–	–	Alteutha crenulata.
–	–	–	–	–	–	–	–	–	–	–	Diosaccus tenuicornis.
–	–	–	–	–	–	–	–	–	–	–	Thalestris clausii.
–	–	–	–	–	–	–	–	–	–	–	Thalestris rufocincta.
–	–	–	–	–	–	–	–	–	–	–	Thalestris helgolandica.
–	–	–	–	–	–	–	–	–	–	–	Thalestris harpactoides.
–	–	–	–	–	–	–	–	–	–	–	Thalestris longimana.
–	–	–	–	–	–	–	–	–	–	–	Idya furcata.
–	–	–	–	–	–	–	–	–	–	–	Harpacticus { chelifer, + gracilis.
–	–	–	–	–	–	–	–	–	–	–	Caligus.

TABLE OF DISTRIBUTION AND

	DATE.	APRIL.							MAY.		
		23rd.			29th.	30th.			8th.		
	STATION NO.	XXVIII. ML			XXIX. ML	XXX. ML.			XXXI. ML		
		A	B	C		A	B	C	A	B	C
Hour,		11.30 p.m.			6 p.m	9.35 p.m			11.0 p.m.		
Time fishing,		—			10 min.	10 min.			—		
Distance from mainland,		8½ miles.			1 m.	10 miles.			6½ miles.		
Depth of water,		63 f.			14 f.	56 f.			60 f.		
Depth of net,		1	30	60	0	1	27	55	1	30	58
Total catch in cc.,		3	12	5	210	4	11	13	1	4	17
Catch of Copepods,		2·5	9	4·5	210	3·5	10	12	·75	3·5	3
Calanus finmarchicus,		A	C	A	A	A	A	F	–	–	M
Eucalanus elongatus,		–	–	–	–		–	–	–	–	–
Paracal. parvus,		VF	VF	VF	VF	VF	VF	F	–	–	F
Calocal. styliremis,		–	–	–	–	–	–	–	–	–	–
Clausocal. arculcornis,		–	–	–	–	–	–	–	–	–	–
Otenocal. vanus,		–	–	–	–	–	–	–	–	–	–
Pseudocal. elongatus,		M	A	M	VF	M	C	M	–	–	M
Bradyidius armatus,		–	–	–	–	–	–	–	–	–	–
Scolecithrix pygmæa,		–	–	–	–	–	–	–	–		–
Centropages typicus,		VF	VF	VF	VF	VF	VF	VF	–	–	VF
Centropages hamatus,		–	(1)	–	VF	–	–	–	–	–	VF
Isias clavipes,		–	–	–	VF	–	–	–	–	–	–
Temora longicornis,		(1)	VF	(1)	VF	–	(1)	VF	–	–	VF
Metridia lucens,		M	M	M	–	M	C	A	–	–	A
Candacia pectinata,		–		–	–	–	–	–	–	–	–
Anomalocera patersoni,		–	–	–	VF	–	–	–	–	–	–
Parapontella brevicornis,		–	–	–	VF	–	–	–	–	–	–
Acartia clausi,		VF	VF	VF	VF	VF	VF	VF	–	–	VF
Acartia discaudata,		–	–	–	–	–	–	–	–	–	–
Olthona similis,		VF	VF	VF	–	VF	VF	VF	–	–	VF
Olthona plumifera,		–	–	–	–	–	–	–	–	–	(1)
Oithona nana,		–	–	–	–	–	–	–	–	–	–
Oncæa conifera,		–	–	–	–	–	–	VF	–	–	–
Oncæa media,		–	–	–	–	–	–	–	–	–	–
Corycæus anglicus,		–	–	–	–	–	–	–	–	–	–
Longipedia coronata,		–	–	–	–	–	–	–	–	–	–
Dactylopus stromii,		–	–	–	–	–	–	VF	–	–	–
Dactylopus tisboides,		–	–	–	–	–	–	–	–	–	–
Alteutha crenulata,		–	–	–	–	–	–	–	–	–	–
Diosaccus tenuicornis,		–	–	–	–	–	–	–	–	–	–
Thalestris clausii,		–	–	–	–	–	–	–	–	–	–
Thalestris rufocincta,		–	–	–	–	–	–	–	–	–	–
Thalestris helgolandica,		–	–	–	–	–	–	–	–	–	–
Thalestris harpactoides,		–	–	–	–	–	–	–	–	–	–
Thalestris longimana,		–	–	–	–	(1)	(1)	–	–	–	–
Idya furcata,		–	–	–	–	–	–	–	–	–	–
Harpacticus {chelifer, + gracilis,}		–	–	–	VF	–	(1)	–	–	–	–
Caligus,		–	–	–	–	–	–	–	–	–	–

RELATIVE ABUNDANCE—*continued.*

MAY.									JUNE.			DATE. 1901.
13th.			22nd.			30th.			3rd.			
XXXIV. M L			XXXVIII. M L			XXXIX. M L			XL. M L			STATION NO.
A	B	C	A	B	C	A	B	C	A	B	C	
12.30 a.m.			10.10 p.m.			10.0 p.m.			10.20 p.m.			Hour.
10 min.			10 min.			30 min.			10 min.			Time fishing.
10½ miles.			8½ miles.			9 miles.			12 miles.			Distance from mainland.
59 f.			59 f.			49 f.			50 f.			Depth of water.
1	30	58	1	30	58	1	25	48	1	25	49	Depth of net.
3	–	11	2	10	14	·5	1·5	19	1	4	14	Total catch in cc.
	—			—		(109)	(200)	–		—		Catch of Copepods.
M	–	C	C	C	C	A	A	A	C	F	M	Calanus finmarchicus.
–	–	–	–	–	–	–	–	–	–	–	–	Eucalanus elongatus.
VF	–	VF	VF	F	F	F	F	VF	VF	VF	VF	Paracal. parvus.
–	–	–	–	(1)	–	–	–	–	–	–	–	Calocal. styliremis.
–	–	–	–	–	–	–	–	–	–	–	–	Clausocal. arcuicornis.
–	–	–	–	–	–	–	–	–	–		–	Ctenocal. vanus.
C	–	C	M	F	C	VF	F	VF	C	M	M	Pseudocal. elongatus.
–	–	–	–	–	–	–	–	–	–	–	–	Bradyidius armatus.
–	–	–	–	–	–	–	–	–	–	–	–	Scolecithrix pygmæa.
VF	–	VF	(1)	VF	VF	–	VF	VF	VF	VF	VF	Centropages typicus.
–	–	–	–	–	–	–	VF	(1)	–	VF	VF	Centropages hamatus.
–	–	–	–	–	–	–	–	(1)	(1)	VF	VF	Isias clavipes.
–	–	VF	–	1	VF	2	–	VF	VF	VF	VF	Temora longicornis
C	–	C	C	C	C	VF	M	C	A	A	A	Metridia lucens.
–	–	–	–	–	–	–	–	–	–	–	–	Candacia pectinata.
–	–	–	–	–	–	–	–	–	–	–	–	Anomalocera patersoni.
–	–	–	–	–	–	–	–	–	–	(1)	–	Parapontella brevicornis.
VF	–	VF	F	VF	VF	F	VF	VF	F	F	F	Acartia clausi.
–	–	–	–	–	–	–	–	–	–	–	–	Acartia discaudata.
VF	–	VF	VF	VF	VF	M	VF	VF	VF	VF	VF	Oithona similis.
–	–	–	–	(1)	(1)	–	–	–	–	–	(1)	Oithona plumifera.
–	–	–	–	–	–	–	–	–	–	–	–	Oithona nana.
–	–	(1)	–	–	VF	–	–	–	–	–	–	Oncæa conifera.
–	–	–	–	–	–	–	–	–	–	–	–	Oncæa media.
–	–	–	–	–	–	–	–	–	–	–	–	Corycæus anglicus.
–	–	–	–	–	–	–	–	–	–	–	–	Longipedia coronata.
–	–	–	–	–	–	–	–	–	–	–	–	Dactylopus stromii.
–	–	–	–	–	–	–	–	–	–	–	–	Dactylopus tisboides.
–	–	–	–	–	–	–	–	–	–	–	–	Alteutha crenulata.
–	–	–	–	–	–	–	–	–	–	–	–	Diosaccus tenuicornis.
–	–	–	–	–	–	–	–	–	–	–	–	Thalestris clausii.
–	–	–	–	–	–	–	–	–	–	–	–	Thalestris rufocincta.
–	–	–	–	–	–	–	–	–	–	–	–	Thalestris heligolandica.
–	–	–	–	–	–	–	–	–	–	–	–	Thalestris harpactoides.
–	–	–	–	–	–	·	–	–	–	–	–	Thalestris longimana.
–	–	–	–	–	–	–	–	–	–	–	–	Idya furcata.
–	–	–	–	–	–	–	–	–	–	–	–	Harpacticus { chelifer. + gracilis.
–	–	–	–	–	–	–	–	–	–	–	–	Caligus.

TABLE OF DISTRIBUTION AND

DATE.	JUNE.									JULY.		
	11th.			18th.			25th.			3rd.		
STATION NO.	XLII. M L			XLIII. M L			XLV. M L			XLVIII. M L		
	A	B	C	A	B	C	A	B	C	A	B	C
Hour,	6.20 p.m.			10.30 p.m.			10.0 p.m.			10.20 p.m		
Time fishing	10 min.			30 min.			10 min.			—		
Distance from mainland,	6½ miles.			10 miles.			4 miles.			5 miles.		
Depth of water,	30 f.			50 f.			52 f.			50 f.		
Depth of net,	1	12	25	1	25	49	1	25	51	1	24	48
Total catch in cc.,	1	7	13	2·75	5	13	·5	2	2·5	1·5	5	3
Catch of Copepods,	–	–	–		—		(115)	–	–	(147)	–	–
Calanus finmarchicus,	VF	M	M	M	C	C	A	M	C	A	C	C
Eucalanus elongatus,	–	–	–	–	–	–	–	–	–	–	–	–
Paracal. parvus,	F	F	VF	VF	VF	VF	–	F	F	VF	VF	VF
Calocal. styliremis.	–	–	–	–	–	–	–	–	–	–	–	–
Clausocal arcuicornis,	–	–	–	–	–	–	–	–	–	–	–	–
Ctenocal. vanus,	–	–	–	–	–	(1)	–	–	–	–	–	–
Pseudocal. elongatus,	(1)	VF	C	M	F	M	VF	C	C	M	C	C
Bradyidius armatus,	–	–	–	–	–	–	–	–	–	–	–	–
Scolecithrix pygmæa,	–	–	–	–	–	–	–	–	–	–	–	–
Centropages typicus,	–	F	M	VF	–	VF	VF	(1)	(1)	(1)	–	VF
Centropages hamatus,	(1)	F	VF	–	–	VF	VF	VF	VF	–	VF	VF
Isias clavipes,	–	VF	VF	(1)	–	VF	–	VF	VF	(1)	–	–
Temora longicornis,	O	A	A	VF	M	M	(1)	F	VF	–	F	VF
Metridia lucens,	(1)	–	F	A	A	C	F	C	A	M	C	C
Candacia pectinata,	–	–	–	–	–	–	–	–	–	–	–	–
Anomalocera patersoni,	–	–	–	–	–	–	–	–	–	–	–	–
Parapontella brevicornis,	–	–	–	–	–	–	–	–	–	–	–	–
Acartia clausi,	A	M	M	F	VF	F	F	F	F	F	VF	VF
Acartia discaudata,	–	–	–	–	–	–	–	–	–	–	–	–
Oithona similis,	F	VF	F	VF	VF	VF	–	VF	F	M	VF	F
Oithona plumifera,	–	–	–	–	–	–	–	–	–	–	–	–
Oithona nana,	–	–	–	–	–	–	–	–	–	–	–	–
Oncæa conifera,	–	–	–	–	–	–	–	–	–	–	–	–
Oncæa media,	–	–	–	–	–	–	–	–	–	–	–	–
Corycæus anglicus,	–	–	–	–	–	–	–	–	–	–	–	–
Longipedia coronata,	–	–	–	–	–	–	–	–	–	–	–	–
Dactylopus stromii,	–	–	–	–	–	–	–	–	–	–	–	–
Dactylopus tisboides,	–	–	–	–	–	–	–	–	–	–	–	–
Alteutha oreulata,	–	–	–	–	–	(1)	–	–	–	–	–	–
Diosaccus tenuicornis,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris clausii,	–	–	–	–	–	–	–	–		–	–	–
Thalestris rufocincta,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris helgolandica,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris harpactoides,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris longimana,	–	–	–	–	–	–	–	–	–	–	–	–
Idya furcata,	–	–	–	–	–	–	–	–	–	–	–	–
Harpacticus {chelifer, + gracilis.}	–	–	–	(1)	–	–	–	–	–	–	–	–
Caligus,	–	–	–	–	–	–	–	–	–	–	–	–

RELATIVE ABUNDANCE—*continued.*

JULY.													DATE. 1901.
9th.			19th.			22nd.			31st.				
XLIX. M L			LI. M L			LIII. M L			LVIII. M L				STATION NO.
A	B	C	A	B	C	A	B	C	A	B	C		
9.30 p.m.			9.30 p.m.			—			9.0 p.m.				Hour.
30 min.			30 min.			—			30 min.				Time fishing.
7½ miles.			7½ miles.			7½ miles.			6 miles.				Distance from mainland.
57 f.			55 f.			30 f.			61 f.				Depth of water.
1	28	56	1	27	53	1	15	28	1	30	60		Depth of net.
1·5	4·5	3	1·5	1·5	14	·25	6	1·5	·5	10	6·5		Total catch in cc.
—			(440)	–	–	(60)	(172)	(160)		—			Catch of Copepods.
–	F	M	F	M	F	F	C	M	–	M	C		Calanus finmarchicus
–	–	–	–	–	–	–	–	–	–	–	–		Eucalanus elongatus.
–	VF	VF	VF	VF	VF	VF	F	M	–	VF	VF		Paracal. parvus.
–	–	–	–	–	–	–	–	–	–	–	–		Calocal. styliremis.
–	–	–	–	–	–	–	–	–	–	–	–		Clausocal. arcuicornis.
–	–	–	–	–	–	–	–	–	–	–	–		Ctenocal. vanus.
–	VF	M	F	F	F	M	C	C	–	F	M		Pseudocal. elongatus.
–	–	–	–	–	–	–	–	–	–	–	–		Bradyidius armatus.
–	–	–	–	–	–	–	–	–	–	–	–		Scolecithrix pygmæa.
–	–	–	–	–	–	–	(1)	–	–	VF	VF		Centropages typicus.
–	–	–	–	VF	–	–	VF	VF	–	(1)	–		Centropages hamatus.
–	–	(1)	–	–	–	–	–	(1)	–	–	VF		Isias clavipes.
–	(1)	VF	VF	VF	VF	VF	VF	VF	–	VF	VF		Temora longicornis.
–	A	A	A	A	A	VF	M	M	(1)	C	C		Metridia lucens.
–	–	–	–	–	–	–	–	–	–	–	–		Candacia pectinata.
–	–	–	–	–	–	–	–	–	–	–	–		Anomalocera patersoni.
–	–	–	–	–	–	–	–	–	–	–	–		Parapontella brevicornis.
–	–	VF	VF	VF	VF	A	M	M	A	C	F		Acartia clausi.
–	–	–	–	–	–	–	–	–	–	–	–		Acartia discaudata.
–	VF	VF	M	F	VF	–	VF	F	–	VF	M		Oithona similis.
–	–	(1)	–	–	VF	–	–	–	–	–	(1)		Oithona plumifera.
–	–	–	–	–	–	–	–	–	–	–	–		Oithona nana.
–	–	–	–	–	–	–	–	–	–	–	–		Oncæa conifera.
–	–	–	–	–	–	–	–	–	–	–	–		Oncæa media.
–	–	–	–	–	–	–	–	–	–	–	–		Corycæus anglicus.
–	–	–	–	–	–	–	–	–	–	–	–		Longipedia coronata.
–	–		–	–	–	–	–	–	–	–	–		Dactylopus stromii.
–	–	–	–	–	–	–	.	–	–	–	–		Dactylopus tisboides.
–	–	–	–	–	–	(1)	–	–	–	–	–		Alteutha crenulata.
–	–	–	–	–	–	–	–	–	–	–	–		Diosaccus tenuicornis.
–	–	(1)	–	–	–	–	–	–	–	–	–		Thalestris clausii.
–	–	–	–	–	–	–	–	–	–	–	–		Thalestris rufocincta.
–	–	–	–	–	–	–	–	–	–	–	–		Thalestris heligolandica.
–	–	–	–	–	–	–	–	–	–	–	–		Thalestris harpactoides.
–	–	–	–	–	–	–	–	–	–	–	–		Thalestris longimana.
–	–	–	–	–	–	–	–	–	–	–	–		Idya furcata.
–	–	–	(1)	–	–	–	–	–	–	–	–		Harpaticus { chelifer, + gracilis.
–	–	–	–	–	–	–	–	–	–	–	–		Caligus.

TABLE OF DISTRIBUTION AND

DATE.	AUGUST.									SEPTEMBER.		
	6th.			12th.			28th.			3rd.		
STATION NO.	LX. M L			LXI. M L			LXVII. M L			LXIX. M L		
	A	B	C	A	B	C	A	B	C	A	B	C
Hour,	9.0 p.m.			10.30 p.m.			7.30 p.m.			7.40 p.m.		
Time fishing,	30 min.			30 min.			10 min.			10 min.		
Distance from mainland,	—			5½ miles.			4½ miles.			7 miles.		
Depth of water,	39 f.			55 f.			30 f.			26 f.		
Depth of net,	1	20	38	1	27	54	1	15	30	1	13	26
Total catch in cc.,	4·5	5	3	1·5	1	13	5	6	6	1	·75	3
Catch of Copepods,		—			—			—			—	
Calanus finmarchicus,	M	C	C	C	A	C	VF	M	VF	VF	VF	F
Eucalanus elongatus,	–	–	–	–	–	–	–	–	–	–	–	–
Paracal. parvus,	VF	–	VF	VF	VF	VF	VF	M	F	M	M	M
Calocal. stylicremis,	–	–	–	–	–	–	–	1	–	–	–	–
Clausocal. arcuicornis,	–	–	–	–	–	–	–	–	–	–	–	–
Ctenocal. vanus,	–	–	–	–	–	–	–	–	–	–	–	–
Pseudocal. elongatus,	C	C	C	F	VF	M	–	M	F	M	F	F
Bradyidius armatus,	–	–	–	–	–	–	–	–	–	–	–	–
Scolecithrix pygmæa,	–	–	–	–	–	–	–	–	–	–	–	–
Centropages typicus,	VF	VF	F	VF	VF	VF	F	F	VF	F	F	F
Centropages hamatus,	VF	VF	VF	VF	VF	VF	F	VF	VF	–	VF	VF
Isias clavipes,	VF	VF	F	VF	(1)	VF	–	VF	–	–	–	VF
Temora longicornis,	–	VF	F	VF	(1)	F	VF	F	F	VF	F	M
Metridia lucens,	M	M	C	C	C	A	–	VF	M	VF	VF	C
Candacia pectinata,	–	–	–	–	–	–	–	–	–	–	–	–
Anomalocera patersoni,	–	–	–	–	–	–	–	–	–	–	–	–
Parapoutella brevicorus	–	–	–	–	–	–	–	–	–	–	–	–
Acartia clausi,	A	C	C	C	M	M	A	A	A	A	A	C
Acartia discaudata,	–	–	–	–	–	–	–	–	–	–	–	–
Oithona similis,	VF	F	M	VF	–	VF	F	M	F	VF	F	F
Oithona plumifera,	–	–	VF	–	–	–	–	–	–	–	VF	VF
Oithona naua,	–	–	–	–	–	–	–	–	–	–	–	–
Oncæa conifera,	–	–	–	–	–	–	–	–	–	–	–	–
Oncæa media,	–	–	–	–	–	–	–	–	–	–	–	–
Coryocæus anglicus,	–	–	–	–	–	–	–	–	–	–	–	–
Longipedia coronata,	–	–	–	–	–	–	–	–	VF	–	–	–
Dactylopus stromii,	–	–	–	–	–	–	–	–	–	–	–	–
Dactylopus tisboides,	VF	–	–	–	–	–	VF	–	–	–	–	–
Alteutha crenulata,	–	–	–	–	–	–	–	–	–	–	–	–
Diosaccus tenuicornis,	–	–	–	–	–	–	–	–	(1)	–	–	–
Thalestris clausii,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris rufociucta,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris heligolandica,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris harpactoides,	–	–	–	–	–	–	–	–	–	–	–	–
Thalestris longimana,	–	–	–	–	–	–	–	–	–	–	–	–
Idya furcata,	–	–	–	–	–	–	–	–	–	–	–	–
Harpacticus { cholifer, + gracilis, }	(1)	–	–	–	–	–	–	–	–	–	–	–
Caligus,	(1)	–	–	–	–	–	–	–	–	–	–	–

RELATIVE ABUNDANCE—*continued.*

SEPTEMBER.			OCTOBER.						NOVEMBER.			DATE. 1901.
9th.			11th.			21st.			1st.			
LXX. M L			LXXXVI. M L			XCVI. M L			OIII. M L			STATION NO.
A	B	C	A	B	C	A	B	C	A	B	C	
8.0 p.m.			6.0 p.m.			7.0 p.m.			6.0 p.m.			Hour.
30 min.			30 min.			60 min.			40 min.			Time fishing.
8 miles.			1½ miles.			½ mile.			1¼ miles.			Distance from mainland.
42 f.			14 f.			18 f.			17 f.			Depth of water.
1	20	40	1	7	14	1	9	18	1	6	16	Depth of net.
1	·75	2	3	3·5	–	3	–	1	1	·25	·75	Total catch in cc.
	—		(163)	(123)	–	(25)	–	(42)	(38)	(103)	(150)	Catch of Copepods.
M	F	F	VF	VF	–	F	–	F	F	VF	VF	Calanus finmarchicus.
–	–	(1)	–	–	–	–	–	–	–	–	–	Eucalanus elongatus.
C	F	C	F	F	–	O	–	F	F	M	M	Paracal. parvus.
–	–	–	–	–	–	–	–	–	–	–	–	Calocal. styliremis.
–	–	–	–	–	–	–	–	–		–	–	Clausocal. arcuicornis.
–	–	–	–	–	–	–	–		–	–	–	Ctenocal. vanus.
VF	M	C	M	F	–	(1)	–	F	F	–	F	Pseudocal. elongatus.
–	–	–	–	–	–	–	–	–	–	–	–	Bradyidius armatus.
–	–	–	(1)	(1)	–	–		–	–	–	–	Scolecithrix pygmæa.
M	F	M	VF	VF	–	F	–	(1)	(1)	(1)	VF	Centropages typicus.
VF	VF	VF	(1)	VF	–	–	–	(1)	(1)	VF	VF	Centropages hamatus.
VF	VF	–	VF	F	–	(1)	–	–	–	–	–	Isias clavipes.
F	F	VF	F	M	–	(1)	–	(1)	VF	VF	VF	Temora longicornis.
VF	F	F	F	VF	–	(1)	–	VF	F	M	F	Metridia lucens.
–	(1)	–	–	–	–	–	–	–	–	–	–	Candacia pectinata.
–	–	–	–	–	–	–	–	–	–	–	–	Anomalocera patersoni.
–	–	–	(1)	–	–	–	–	–	–	–	–	Parapontella brevicornis.
A	A	A	O	C	–	M	–	A	C	F	A	Acartia clausi.
–	–	–	–	–	–	–	–	–	–	–	–	Acartia discaudata.
F	F	F	VF	VF	–	(1)	–	F	(1)	C	F	Oithona similis.
–	–	–	–	–	–	–	–	–	–	–	–	Oithona plumifera.
–	–	–	(1)	(1)	–	–	–	–	–	–	–	Oithona nana.
–	–	–	–	–	–	–	–	–	–	–	–	Oncæa conifera.
–	–	–	–	–	–	–	–	–	–	–	–	Oncæa media.
–	–	–	–	–	–	–	–	–	–	–	–	Corycæus anglicus.
–	–	–	(1)	–	–	–	–	–	–	–	VF	Longipedia coronata.
–	–	–	–	–		–	–	–	(1)	–	–	Dactylopus stromii.
–	–	–	(1)	–	–	–	–	–	–	–	–	Dactylopus tisboides.
–	–	–	–	–	–	–	–	–	–	–	–	Alteutha crenulata.
–	–	–	–	–	–	–	–	–	–	–	–	Diosaccus tenuicornis.
–	–	–	(1)	–	–	–	–	–	–	–	–	Thalestris clausii.
–	–	–	–	–	–	–	–	–	(1)	–	–	Thalestris rufocincta.
–	–	–	–	–	–	–	–	–	–	–	–	Thalestris heligolandica.
–	–	–	–	–	–	–	–	–	–	–	–	Thalestris harpactoides.
–	–	–	(1)	–	–	–	–	–	–	–	(1)	Thalestris longimana.
–	–	–	VF	(1)	–	–	–	–	F	–	–	Idya furcata.
(1)	–	–	F	(1)	–	–	–	–	–	–	(1)	Harpacticus { chelifer. + gracilis.
–	–	–	–	–	–	–	–	–	–	–	–	Oaligus.

TABLE OF DISTRIBUTION, &c.—*continued.*

1901.	DATE.	NOVEMBER.								DEC.	
		8th.			22nd.			29th.		17th.	
	STATION NO.	CVI. M L			CVIII. M L			CXIII. M L		CXVI. M L	
		A	B	C	A	B	C	A	B	A	B
Hour,		5.0 p.m.			4.0 p.m.			11.0 a.m.		1.15 p.m.	
Time fishing,		60 min.			40 min.			10 min.		30 min.	
Distance from mainland,		2 miles.			2 miles.			2½ miles		1½ miles.	
Depth of water,		15 f.			18 f.			20 f.		14 f.	
Depth of net,		1	7	14	1	9	17	1	18	1	14
Total catch in cc.,		15	5	25	1	3	4·5	4	4·5	3	2
Catch of Copepods,		–	–	16		—		·75	–	—	
Calanus finmarchicus,		F	M	A	M	C	M	M	VF	VF	VF
Eucalanus elongatus,		–	–	–	–	–	–	–	–	–	–
Paracal. parvus,		C	M	M	C	F	M	C	VF	VF	VF
Calocal. styliremis,		–	–	–	–	–	–	–	–	–	–
Clausocal. arcuicornis,		–	–	–	–	–	–	–	–	–	–
Ctenocal. vanus,		–	–	–	–	–	–	–	–	–	–
Pseudocal. elongatus,		VF	F	VF	VF	F	M	F	M.	A	A
Bradyidius armatus,		–	–	–	–	–	–	–	–	–	–
Scolecithrix pygmæa,		–	–	–	–	–	–	–	–	–	–
Centropages typicus,		VF	F	VF	VF	VF	VF	–	VF	VF	VF
Centropages hamatus,		VF	–	–	–	–	–	–	–	VF	VF
Isias clavipes,		–	–	VF	–	–	VF	–	–	–	VF
Temora longicornis,		VF	VF	VF	–	VF	VF	–	VF	VF	F
Metridia lucens,		A	A	M	A	A	A	C	A	VF	M
Candacia pectinata,		–	–	–	–	(1)	–	–	(1)	–	–
Anomalocera patersoni,			–	–	–	–	–	–	–	–	–
Parapontella brevicornis,			–	–	–	–	(1)	–	–	–	–
Acartia clausi,		VF	F	VF	VF.	F	F	F	VF	C	M
Acartia discaudata,		–	–	–	–	–	–	–	–	(1)	–
Oithona similis,		VF	VF	VF	F	VF	VF	M	VF	VF	(1)
Oithona plumifera,		–	–	–	–	–	–	–	(1)	–	–
Oithona nana,		–	–	–	–	–	–	–	–	VF	–
Oncæa conifera,		–	–	–	–	–	–	–	–	–	–
Oncæa media,		–	–	–	–	–	–	–	–	–	–
Corycæus anglicus,		VF	(1)	VF	VF	(1)	(1)	–	(1)	(1)	(1)
Longipedia coronata,		–	–	–	–	(1)	–	–	–	–	–
Dactylopus stromii,		–	–	–	–	–	–	–	–	–	–
Dactylopus tisboides,		–	–	–	–	–	–	–	–	–	–
Alteutha crenulata,		–	–	–	–	–	–	–	–	–	–
Diosaccus tenuicornis,		–	–	–	–	–	–	–	–	–	–
Thalestris clausii,		–	–	–	–	–	–	–	–	–	–
Thalestris rufocincta,		–	–	–	–	–	(1)	–	–	(1)	–
Thalestris helgolandica,		–	–	–	–	–	–	–	–	–	(1)
Thalestris harpactoides,		–	–	–	–	–	–	–	–	–	–
Thalestris longimana,		–	–	–	–	–	–	–	–	–	–
Idya furcata,		–	–	–	–	–	–	–	–	(1)	–
Harpacticus {chelifer, + gracilis.}		–	–	–	–	–	–	–	–	–	–
Caligus,		–	–	–	–	–	–	–	–	–	–

It may be noted here that the catch of plankton, apart from its actual abundance in the sea, seems to depend on a great variety of circumstances; the time during which the net is fishing having apparently very little effect. The tow-nettings were, in most cases, taken while the "Monica" was drifting with a train of mackerel nets, her rate of movement through the surrounding water, depending on the force of the wind, being usually scarcely enough to bring the surface tow-net out of the vertical. The bottom and middle tow-nets often tailed away considerably from the boat, evidently owing to the existence of a tidal surface current, and thus strained a much larger amount of water than the surface net. This is one factor which must be allowed for in comparing the catches of the surface and bottom nets. Another, and probably a more important one, is the fact that the tow-nets, being of the ordinary open ring pattern, were fishing during the time that they were being hauled. It seems reasonable to suppose that a tow-net hauled rapidly for a distance of, say, 60 fathoms, or 120 yards, should catch as much as one towed very slowly for a longer distance, especially of such active swimmers as copepods. As an instance of this, it may be mentioned that on 25th June, simultaneously with the bottom tow-net, another tow-net was shot, which was hauled again immediately on its reaching bottom. The catch of this net measured 4 c.c., while that of the bottom tow-net, which was towed for ten minutes, was only 2·5 c.c.

The large catch on November 8th was due to the fact that the tow-nets were out while the train of mackerel nets was being hauled, and were thus towed much faster than usual.

ii.—List of the Copepods taken, with Notes.

The following list includes only the species which occurred in 1901, in tow-nettings taken by the "Monica," on the mackerel fishing grounds off Ballinakill. The notes on their distribution and occurrence refer to the same area, except when otherwise stated. The nomenclature followed is that of Giesbrecht, as given in "Das Tierreich," Berlin, 1898.

Calanus finmarchicus (Gunn.).—This is the most abundant species and the most important from an economic point of view. It reaches its maximum in April. A very remarkable haul of this copepod was made on April 29th, about two miles outside the mouth of the Ballinakill Harbour, 210 c.c. being taken in the surface tow-net hauled slowly for ten minutes. The time was 6.0 p.m., the evening being calm and sunny, and the sea smooth. A few days later large numbers were left dying on the shores of the bay by the tide.

Eucalanus elongatus (Dana).—Occurred once, on September 9th.

Paracalanus parvus (Claus.).—Occurred constantly throughout the year in small quantities, becoming more common in winter.

Calocalanus styliremis Giesbr.—One specimen in very bad condition, taken on May 22nd.

Clausocalanus arcuicornis (Dana).—A few specimens, all females, taken in the spring.

Ctenocalanus vanus Giesbr.—A single specimen, ♀, was taken on June 18th. It has possibly been passed over on other occasions, as it has a great resemblance to *Paracalanus parvus*. The features by which it may most easily be distinguished under a low power, or dissecting microscope, are the length of its first antenna, which exceeds that of the whole animal, and a sort of transparency or absence of opaque contents in the upper part of its head, though I cannot say whether the latter characteristic is constant or not.

Pseudocalanus elongatus (Boeck.).—Present throughout the year, but scarce in winter. Next to *Calanus finmarchicus* and *Metridia lucens*, this is the commonest copepod in the district. Very large specimens were met with in spring, the maximum sizes noted for ♂ and ♀ respectively being 1·44 mm. and 1·9 mm. These figures are in excess of the maximum limits given by Giesbrecht (♂ 1·36 mm., ♀ 1·63 mm.)

Chiridius armatus (Boeck.).—A single specimen ♀ which appears to belong to this species was taken in the surface mosquito-net tow-net on April 30th. As there appears to be a certain amount of uncertainty connected with the identification of this and closely allied species I have given a detailed description of my specimen below.

Bradyidius armatus (Vanhöffen).—A single specimen, ♀ taken in February.

Scolecithrix minor, Brady.—One specimen, ♀, of a form which agrees with that referred by Prof. Sars to this species (*Crustacea of Norway*, vol. iv., p. 55) was taken in a bottom tow-net on July 31st.

Scolecithrix pygmæa, T. Scott.—Occurred a few times when the tow-nets were taken nearer shore than usual.

Centropages typicus, Kröyer.—Present in most of the tow-nettings, but in small numbers.

C. hamatus (Lillj.).—Occurred all through the year, but was scarcer than the preceding.

Isias clavipes, Boeck.—Taken not infrequently, but in very small numbers.

Temora longicornis (Müll.).—Present in most of the tow-nettings. It is usually found in small numbers, but on one occasion, June 11th, it formed the greater part of the contents of both middle and bottom tow-nets, and on May 8th the mackerel were found to be feeding on it almost exclusively.

Metridia lucens, Boeck.—Forms, with *Calanus finmarchicus*, the main bulk of the tow-net contents, and also of the food of the mackerel in spring and early summer. This species, as its name indicates, is very luminous, giving a brilliant blue-green light when disturbed. It seems during the spring, before the development of the rich summer plankton, to be the principal cause of "fire" in the sea on this coast.

A large number, at least one third, of the males were noticed to have their clasping antenna on the left side, being in other respects identical with the typical *M. lucens* ♂. This fact has also been noted by Dr. Wolfenden with reference to the same species in the Faröe Channel.—(*Journal Marine Biological Association*, N.S., Vol. VI., No. 3, p. 363.)

Candacia pectinata, Brady.—Single specimens occurred a few times in autumn.

Anomalocera patersoni, Templ.—Rarely found in the fine meshed tow-nets, but is taken more often in the large.

Parapontella brevicornis (Luhh.).—Very scarce in the "Monica's" tow-nettings, though it is plentiful close to shore.

Acartia clausi, Gieshr.—Taken all through the year, becoming more common in autumn. Neither *A. longiremis* nor *A. bifilosa* has yet been met with; but they may have been overlooked, as it was impossible to examine minutely more than a small proportion of the specimens of *Acartia*.

Acartia discaudata (Giesbr.).—Only single specimens were taken a few times at sea, though in Ballynakill Harbour this is one of the commonest copepods.

Oithona similis, Claus.—Almost always present, hut never plentiful.

O. plumifera, Baird.—Has been taken several times, but usually only single specimens on each occasion. They were all ♀, and while agreeing closely with Gieshrecht's figures (*Flora und Fauna des Golfes von Neapel*, Vol. 19, Pl. 34) of first to fourth foot, differ in that they, or at least any that have been examined, hear four setæ on the inner hranch of the mandible.

O. nana, Giesbr.—Found a few times in tow-nettings, taken near shore in autumn and winter. It is not uncommon in the sheltered waters of Ballynakill and Killary Harhours.

Oncœa conifera, Gieshr.—A few specimens were taken in spring.

O. media, Gieshr.—A single specimen, ♀, was taken ou September 3rd. It differed in a few points from Giesbrecht's description of the species, the furcal hranches heing three times as long as hroad instead of two and a half times, and the first three joints of first antenna being in the proportion of 4 : 6 : 11, instead of 3 : 6 : 9. The terminal joints of first antennæ were missing on hoth sides. It agreed, however, in all important particulars, the inner branch of the fourth foot being without a terminal conical projection, the mandible process heing toothed only on the end, and the genital openings being close together and in advance of the middle of the genital segment. Its length was ·76 mm., and the head and genital segment were of a reddish orange colour.

Corycæus anglicus, Lubhock.—This species was not met with except in winter, and then occurred in almost every tow-netting, but in small numhers.

Longipedia coronata, Claus.
Diosaccus tenuicornis, Claus.
Dactylopus stromii (Baird).
D. tisboides, Claus.
Thalestris clausii, Norman.
T. rufocincta, Norman.
T. heligolandica, Claus.
T. harpactoides, Claus.
T. longimana, Claus.
Harpacticus chelifer (Müll.).
H. gracilis, Claus.
Alteutha crenulata (Brady).
Idya furcata (Baird).

These are all more or less common shore-haunting species whose occurrence in deep water was accidental.

Of the 39 species noted, most are such as might naturally he expected to occur; eight, however, seem not to have heen yet recorded from

British waters, viz.:—*Calocalanus styliremis, Chiridius armatus, Scolecithrix minor, Clausocalanus arcuicornis, Ctenocalanus vanus, Oithona nana, Oncœa conifera,* and *O. media.*

Of these *Calocalanus styliremis* has been recorded from the Mediterranean and the Pacific; *Chiridius armatus* from the coast of Norway; *Scolecithrix minor* from the Atlantic and Indian Oceans; *Clausocalanus arcuicornis* and *Ctenocalanus vanus* from the Mediterranean, Atlantic, and Pacific; *Oithona nana, Oncœa media* from the Mediterranean; and *Oncœa conifera* from the Mediterranean, Pacific, and Atlantic as far north as the mouth of the St. Lawrence, so that the range of some of them has been considerably extended.

The Copepods in the above list, with a few exceptions, seem to fall into three distinct groups, as follows:—

1. Those which are always present in larger or smaller quantities.
2. Copepods which occur in the tow-nettings in small numbers, and which, in this district at least, are found most abundantly in shallow water near shore or in sheltered bays.
3. Copepods whose natural habitat is probably the open ocean, and which extend their range occasionally to near the coast. These usually occur singly in the tow-nettings.

In the first group may be reckoned *Calanus finmarchicus, Paracalanus parvus, Pseudocalanus elongatus, Centropages typicus, Temora longicornis, Metridia lucens, Acartia clausi,* and *Oithona similis.*

The second group includes *Scolecithrix pygmœa, Centropages hamatus, Isias clavipes, Parapontella brevicornis, Acartia discaudata, Oithona nana,* and the Harpacticids. To these may be added, in winter, *Corycœus anglicus.* Two of these species, viz., *Centropages hamatus* and *Acartia discaudata,* have, perhaps, no right to be called shallow-water copepods, as they have been taken in mid-Atlantic by Prof. Herdman in his "Atlantic Traverse" of 1897 (*Trans. Liverpool Biological Soc.*, vol. xii.). The former was recorded from along the whole route, and the latter was met with both going and returning at the same spot between 90 and 120 miles to the westward of the Rockall bank. This latter record is remarkable, as the species in this neighbourhood seems to be confined to sheltered bays, where it abounds, single specimens having been only taken four times in the open sea, as the table shows.

The copepods of the third group comprise *Eucalanus elongatus, Calocalanus styliremis, Clausocalanus arcuicornis, Ctenocalanus vanus, Oithona plumifera, Oncœa conifera,* and *O. media.* These species, with the exception of *Clausocalanus arcuicornis* and *Oncœa media,* have been found in larger or smaller numbers in a set of tow-nettings taken by the Department's steamer "Helga" in the neighbourhood of the Porcupine Bank, and it seems not unlikely that this is the source from which occasional stragglers reach our shores.

It is possible, however, that they are plentiful close to the bottom, where they would easily escape capture unless by a tow-net attached to a trawl. Mr. T. Scott has recorded *E. crassus* and *E. elongatus* from the bottom of Dornoch Firth (18*th Report, Scotch Fishery Board,* Pt. iii., p. 382), taken by this means, which often produces a rich supply of copepods, and Prof. Sars in his account of the Crustacea of Norway mentions a number of forms as having a distinct bottom-haunting habit.

iii.—Descriptions of Species.

Chiridius armatus (Boeck). (Pl. XVI., figs. 1–13).

♀, length = 4 mm. (cephalothorax to end of lateral spines = 3·2 mm. Abdomen, 1·14 mm.). Body moderately robust, the sides of the head slightly tumid. Head fused to 1st th. seg., 4th and 5th th. seg. fused, the junction being faintly indicated. Last th. seg. produced on either side into a strong point reaching to the middle of genital seg.

Abdomen 4-segmented, the proportional lengths of the segments in mm. being ·4, ·25, ·2, ·14. Furcal branches slightly longer than broad, each with four strong feathered terminal setæ, a very slight, apparently smooth, outer edge seta, and a small feathered seta on the under surface. The inner edges of the furca are feathered.

On the genital segment, arising in the middle of the left side towards the ventral surface, is a small spine which reaches backwards as far as the hinder margin of the segment.

The 1st Antennæ (Pl. xvi., fig. 3) are slightly longer than the cephalothorax, and are 24-jointed, the proportional length of the joints in ·01 mm. being as follows :—

No. ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Length,	30	20	8	8	8	9	9	20	8·5	8·5	9	10	10	12	13	13·5	13·5	19	21	14	16	19	16	4·5

The setæ on joints numbers 13, 17, 20, 23, 24 are longer than the rest, and are rather slender. They exhibit the same "ringing," or, rather, reticulation which is found in *B. armatus*, and which seems to be due to channels or grooves in the thickness of the chitin which forms the seta.

In the 2nd Antennæ (Pl. xvi., fig. 4) the exopodite is about 1½ times as long as the endopodite. The 2nd joint of the exop. bears only a small distal seta, at least no median seta was observed. The 7th joint bears a median seta on the inner side.

Mandible (Pl. xvi., fig. 5) as in *B. armatus*.

Maxilla (Pl. xvi., fig. 8) seems to agree in structure with that of *B. armatus*. The surface of the 1st inner lobe is, however, smooth, and the top of the 3rd inner lobe spinulose.

1st Maxillipede (Pl. xvi., fig. 9) has the inner face of all the lobes, except the 5th, spinulose. The spines on the 5th lobe are only slightly larger than those on the 4th.

2nd Maxillipede (Pl. xvi., fig. 10) 7-jointed, the 2nd joint very long. The feet (Pl. xvi., figs. 7, 11—13) agree with those of *B. armatus* in jointing and number of setæ. They are, however, more slender and less strongly chitinized, and lack the spinules on the outer edge of the basal joints. The 1st foot differs in that the terminal inner edge seta of the 2nd basal joint is not bent across the lobe of the endopodite. This may, however, be an accidental variation in a single specimen.

The distal seta on the inner edge of the 1st joint of endop. is absent in the 1st foot, and in the other is slender and very little longer than the 2nd joint of the endop. 5th feet absent.

A single specimen, ♀, taken on 30th April, 1901, in large surface tow-net of mosquito-net, 5½ miles north-west of Inishark. This is evidently the species which in Sars' Crustacea of Norway (vol. iv., p. 27) is identified with the imperfectly described *Euchaeta armata* of Boeck. Prof. Sars there refers it to the genus Chiridius and states that it is common in the Norwegian Fjords at depths below 100 fathoms.

Gætanus pileatus, n. sp. (?) (Pl. XVII., figs. 1-11).

♀, length 5·93 mm. (cephalothorax 4·93 mm., abdomen 1 mm.). Colour, bright red, extending to all the appendages. Cephalothorax 4-segmented, head being fused with tb. 1, and th. 4 with tb. 5.

The head is produced into a strong spine, which slopes slightly backwards, instead of inclining forwards; as in *G. miles*. Last th. seg. bears on either side a short spine, arising close to binder margin, and projecting downwards and outwards.

Abdomen 4-segmented. The genital segment slightly exceeds the combined length of the three succeeding segments, and has a well-marked projection on its ventral surface. The dorsal margins of the abdominal segments are denticulated.

Furcal branches as wide as long, separated by about their own width, and bearing four stout short densely-feathered terminal setæ, one slender very short outer edge seta, and one longer slender seta arising on the ventral surface.

1st Antennæ (Pl. xvii., fig. 2) very long, slender, 23-jointed, exceeding the whole animal by about the last five joints, with long setæ on 13th, 17th, and 20th joints, and perhaps on others also. Proportional length of the joints in ·01 mm.—

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
36	15	15	18	18	22	39	24	26	28	42	42	46	46	48	48	64	60	49	51	37	36

2nd Antennæ (Pl. xvii., fig. 3).—Outer branch $1\frac{1}{5}$ times as long as inner, 7-jointed. 2nd joint equal to 7th, with small distal seta, but no median seta. Strong setæ on distal edges of 3rd, 4th, 5th, and 6th joints, and a more slender median seta on 7th joint. Inner branch much more slender than outer, 1st joint much thicker at its base than distally.

Mandible (Pl. xvii., fig. 4).—Jointing as in other members of the genus. There is a median seta on the outer edge of the 2nd joint of the basipodite.

Maxilla (Pl. xvii., fig. 5).—The third inner lobe of the basipodite is much broader than the second, and is strongly spinulose on its extremity. The spines on the second lobe are strongly developed.

1st Maxillipede (Pl. xvii., fig. 6).—The inner faces of the second, third, and, to a less extent, the fourth lobe are spinulose.

2nd Maxillipede (Pl. xvii., fig. 7).—The vesicular appendage on the lower edge of the 1st joint resembles somewhat in shape that of *G. miles*, but does not project so far. There is a similar but much smaller appendage, with a pitted surface, at the extremity of the joint, between the terminal lobe and the second joint.

1st foot (Pl. xvii., fig. 8).—As in *G. miles*, with 2-jointed exop., the division of the first joint into two being faintly indicated.

2nd and 3rd feet (Pl. xvii., figs. 9, 10).—As in *G. miles*.

4th foot (Pl. xvii., fig. 11).—The 1st joint of the basip. resembles that of *G. armiger*, bearing distally on its inner edge a row of fine bristles, which are continued across the inner face of the joint.

5th feet absent.

A single specimen, ♀, found in the stomach of a mackerel taken off Cleggan, Co. Galway, on 13th of February, 1901.

The above species is certainly distinct from *G. miles*, *G. armiger*, and *G. caudani*. I have, however, been unable to obtain a copy of the description of *G. denticulatus* Aurivillius, with which it possibly may prove to be identical. It approaches most nearly to *G. miles*, from which it differs in its larger size, the different form of the cephalic spine and of the spines on the last thoracic segment, the length and proportional length of joints of the 1st antenna, and the form of the bristles on the basal joint of the 4th foot.

IV.—Copepods as Fish Food.

During the year (1901) a number of mackerel were examined with a view to ascertaining their food at different seasons. The following is a summary of the results as far as they refer to copepods:—

January.—No mackerel available.

February.—Out of forty-five fish examined, copepods formed the principal food of nine, in all cases in small quantities, and occurred in twenty others as a very small fraction of the contents of the stomachs which were mostly full of schizopods (*Thysanöessa*) and fish remains. The most abundant species was *Metridia lucens*, which was found in almost every instance. The following also occurred, the names being given in the order of their relative abundance:—*Pseudocalanus elongatus*, *Paracalanus parvus*, *Oithona similis*, *Acartia clausi*, *Temora longicornis*, and *Calanus finmarchicus*; the last-named having been only met with twice. A single specimen of a species of *Gætanus*, which appears to be undescribed, was also found, a description of which is given below.

March.—No mackerel were available; however seventeen herrings were examined which gave results very similar to those from the February mackerel. The stomachs were all full of *Thysanöessa*, but contained a number of copepods, principally *Metridia lucens* and *Calanus finmarchicus*, the other species met with being as in February.

April.—Thirty-seven mackerel examined, in all of which copepods formed the main food. In most cases the stomachs had little in them, but some were full. The species represented were *Calanus finmarchicus*, which formed the bulk of the contents in every case, *Pseudocalanus elongatus* occurring in thirty-four stomachs, *Metridia lucens* in twenty-three, *Acartia clausi* in sixteen, *Paracalanus parvus* in five, and *Oithona similis* in one.

May.—Out of twenty-five mackerel, copepods occurred in twenty-three, forming the principal diet of twenty, the stomachs in most cases being full. The species represented were *Calanus finmarchicus*, found in twenty-three, abundant in eleven; *Pseudocalanus elongatus* found in twenty-three, abundant in one; *Metridia lucens* found in fifteen, abundant in one; *Temora longicornis* found in ten, to the exclusion of almost everything else; *Acartia clausi* found in three; *Paracalanus parvus* found in one; and *Oithona similis* in one.

June.—The mackerel divided their attention between copepods and sand-eels. Out of fifty-one stomachs examined copepods occurred in thirty-two, forming almost the entire contents of twenty, and distending them in some cases almost to bursting. Of the rest, three were half full of copepods, and nine contained a small proportion. Early in the month *Calanus finmarchicus* and *Metridia lucens* were met with in equal quantities, but later *M. lucens* became the more abundant. *Pseudocalanus elongatus*, *Acartia clausi*, and *Temora longicornis* were also present in small numbers, and *Oncæa conifera* was found once.

July.—Copepods became much scarcer as an article of diet, since out of thirty-seven stomachs of mackerel examined they were only found in nine, forming the main contents of four. The rest were full of sand-eels, or, in a few instances, of *Spirialis* or larval *Galathea*.

Pseudocalanus elongatus was the most abundant copepod, *Metridia lucens* and *Temora longicornis* occurring in very small numbers.

After July the mackerel appeared to give up feeding on copepods altogether, taking instead to an exclusively fish diet. Only one contrary instance was noted, that of a mackerel taken on 13th August, which was half full of copepods.

It will be seen from the above summary that *Calanus finmarchicus* forms the principal part of the mackerel's copepod food, occurring in much greater quantities in the stomachs than any other species, though the actual number of stomachs in which *Metridia lucens* is met with may he greater. The occasional presence of *Pseudocalanus elongatus* and *Temora longicornis* in immense numbers is remarkable (*P. elongatus* on 23rd May, 11th July, and 31st July, and *T. longicornis* on 8th May), and taken with the tabulated results of tow-nettings seems to show that these species occur at times in dense swarms of limited extent. Another point worth noting is the mode of occurrence of the copepods with relation to the other food-stuffs in the stomach. Sometimes the various contents are irregularly mixed together, while at other times they form distinct strata; *e.g.*, the hottom or cæcal end of the stomach may he filled with spirialis, on top of this being a layer of copepods, while the remainder is made up by sand-eels.

The most probable explanation of cases like the last seems to he, not that the mackerel deliberately alters its diet, hut that it swims successively through swarms of the various organisms in question.

EXPLANATION OF THE PLATES.

The figures were all drawn by means of the *camera lucida*.

Plate XVI.

Chiridius armatus (*Boeck*).

		Diam.
Fig. 1.	—Female, lateral view,	× 19
Fig. 2.	—Female, dorsal view,	× 19
Fig. 3.	—1st Antenna of female,	× 50
Fig. 4.	—2nd Antenna of female,	× 69
Fig. 5.	—Mandible palp of female,	× 69
Fig. 6.	—Cutting edge of mandible,	× 120
Fig. 7.	—1st Foot of female, lower face,	× 69
Fig. 8.	—Maxilla of female (lower lobes omitted),	× 250
Fig. 9.	—1st Maxillipede of female,	× 56
Fig. 10.	—2nd Maxillipede of female,	× 120
Fig. 11.	—2nd Foot of female, upper face,	× 69
Fig. 12.	—3rd Foot of female, upper face,	× 69
Fig. 13.	—4th Foot of female, lower face,	× 69

Plate XVII.

Gaetanus pileatus, *n. sp.*

Fig. 1.	—Female, lateral view,	× 12·5
Fig. 2.	—1st Antenna of female,	× 17
Fig. 3.	—2nd Antenna of female,	× 50
Fig. 4.	—Cutting edge of mandible of female,	× 120
Fig. 5.	—1st Maxillipede of female,	× 69
Fig. 6.	—Maxilla of female (lower lohes omitted),	× 120
Fig. 7.	—2nd Maxillipede of female,	× 69
Fig. 8.	—1st Foot of female, upper face,	× 50
Fig. 9.	—2nd Foot of female, upper face,	× 50
Fig. 10.	—3rd Foot of female, lower face,	× 50
Fig. 11.	—4th Foot of female, upper face,	× 50

G P F del

Gaetanus pileatus, Figs 1 to 11

Appendix, No. VIII.

THE MARINE FAUNA OF THE WEST COAST OF IRELAND.

PART I.

THE NUDIBRANCHIATE MOLLUSCS OF BALLYNAKILL AND BOFIN HARBOURS, CO. GALWAY.

BY

G. P. Farran, B.A.

Plates XVIII. and XIX.

INTRODUCTORY.

The following list of Nudibranchs has been compiled from the records of the Marine Laboratory since its inception in 1899. The species recorded have all been taken either at Inisbofin, where the Laboratory was stationed during the summer and autumn of 1899 and 1900, or at Ballynakill, where it has been for the remainder of the time.

A few of the species were identified by Mr. W. I. Beaumont in the spring of 1899, others have been recorded by the late Mr. M. F. Woodward and by Mr. E. W. L. Holt on various occasions, and for the remainder, mostly taken in 1901 and 1902, I am myself responsible.

This list contains 51 species of which six (*Lamellidoris depressa*, *L. sparsa*, *Cratena viridis*, *Galvina vittata*, *G. cingulata* and *Calma glaucoides*) do not seem to have yet been recorded from the Irish coast. Other points of interest are the occurrence of *Proctonotus mucronifer* in a second Irish locality, the abundance of a red variety of *Eolis glauca* in Bofin Harbour, and also the fact that several of the most remarkable finds recorded by Mr. Beaumont from Valencia Harbour (Proc. Royal Irish Acad. (3), V., 1900) have turned up again in Ballynakill. The number of species in the Valencia list is 48, and of these 37 have been found at Ballynakill or Bofin, notably a small red and white, yellow-bordered Doris, a Lamellidoris with a great resemblance to *L. pusilla*, *Cuthona Peachii*, and two species of Lomanotus.

The collecting grounds at Bofin are much smaller and less varied than at Ballynakill. They consist mainly of the harbour, which is a small inlet with an inner and an outer portion. The inner

harbour is shallow, with a bottom of sandy mud, and is left almost dry at low water. The outer harbour is more extensive, and is bounded on one side by a rocky shore, broken at intervals by sandy beaches, and on the other by a stony beach with a clay foundation. The bottom is sandy, and includes a large zostera bed.

Some dredging was also carried on outside the harbour in 12-15 fathoms where the bottom varies from clean sand to broken shells and slatey gravel.

There is a much greater variety of ground at Ballynakill*; sand is found all along the main channel as far as Coastguard Bay, passing into mud in a few places; the lesser bays have all soft muddy bottoms; the bar at the entrance of Fahy Bay, where the Laboratory is moored, consists mainly of Lithothamnion and a deep depression off Coastguard Bay, referred to in the following notes as Coastguard deep, contains a thick though limited bed of dead shells, such as *Pecten maximus*, Ostrea, Mya, Solen, *Venus exoleta*, &c., with encrusting Polyzoa and sponges and numerous hydroids. This spot proved to be the richest in Nudibranchs in the whole harbour. There are several extensive Zostera-beds, some of which are exposed at low spring tides. On the shore rocks are numerous, but in most places are separated from low water mark by a strip of clean sand; in a few instances, however, *e.g.*, Black Rocks and Roeillaun, they rise directly out of the water. The north shore of Fahy Bay, covered with large stones from the breaking down of an earthen cliff, is very rich in animal life, while apparently similar ground in other parts of the harbour is rather barren.

LIST OF SPECIES.

Archidoris tuberculata (Cuv.).

Common both at Ballynakill and Inisbofin between tide marks and in shallow water below tide marks. The orange and reddish brown varieties are perhaps the most plentiful at Ballynakill.

Jorunna Johnstoni (A. & H.).

Occurs not uncommonly on the shore near low water mark at Ballynakill. First taken by Mr. W. I. Beaumont in March, 1899.

Addisa testudinaria (Risso).

[**Platydoris planata** (A. & H.).]

Taken near the mouth of Ballynakill Harbour under stones at low water, March, 1901.

Caldina repanda (A. & H.).

Met with occasionally near low water mark at Ballynakill.

* See Plate XIX.

Rostanga coccinea (A. & H.)

Found twice at Ballynakill. One under a stone near low water mark, in February, 1901, and again in February, 1902, on a red encrusting sponge on Roeillaun Rocks.

Acanthodoris pilosa (Müll.).

Occurs not infrequently at Ballynakill near low water mark, especially in the more rocky parts of the bay, and is occasionally dredged. The varieties of colour range from pepper and salt to pure white.

Lamellidoris bilamellata (Linn.).

Very abundant and spawning on the sides of the Laboratory along the water-line in the beginning of February, 1902, also on the south shore of Fahy Bay and on Roeillaun Rocks, and in smaller numbers in other parts of the harbour. It was much scarcer in the spring of 1901, and is hardly ever found in summer or autumn. The specimens met with spawning in the more exposed parts of the harbour were much smaller than those on the Laboratory or on the shores of the sheltered waters of Fahy Bay.

Lamellidoris depressa (A. & H.).

This species has been met with several times in October, 1902, amongst Polyzoa-covered shells in the afore-mentioned Coastguard deep, Ballynakill.

Lamellidoris (sp. ?)

A small Lamellidoris agreeing in most points with Alder and Hancock's figure of *L. pusilla* has been found several times in Coastguard deep in company with *L. depressa*. It differs, however, in possessing distinctly spiculose tubercles. This is evidently the same animal as that found by Mr. Beaumont at Valencia (*loc. cit.* p. 850).

Lamellidoris sparsa (A. & H.).

A single specimen was found on a Polyzoan-covered shell from Coastguard deep in October, 1902. It was of a rather redder colour than the specimen figured by Alder and Hancock, and only showed the clear area referred to by them behind the right rhinophore. The reticulated appearance of the under edge of the mantle, which A. and H. explain as being probably due to the ends of spicules appearing through, seems in reality to be caused by numerous granular spicules. The resting position assumed by the animal was almost circular; and when *in situ* on a dead shell it could with difficulty be distinguished from a small red Polyzoan colony, the resemblance in shape, colour and texture being complete.

Doris Beaumonti, n. sp.

Four specimens of a brilliantly coloured little Doris, which has already been met with by Mr. Beaumont at Port Erin and Valencia (*loc. cit.* p. 848), were taken at Ballynakill among dead shells in Coastguard deep in six to eight fathoms. The first was found in April, 1900, and was submitted to Mr. Beaumont, who stated it to be identical with his specimens. As it appears to be still undescribed, I suggest the name *D. Beaumonti* for it. The following is a description as far as it has been possible to make it out:—

Length = 4·5 m.m. Back very high with edges of mantle elevated, slightly upturned in preserved specimens. Tail thick, extending far beyond the mantle, with well-marked keel. Head without tentacles, and not forming a distinct veil, but swollen on either side of the mouth. Rhinophores with six or seven lamellae. Branchial plumes Mr Beaumont states he believes to be retractile, but I have been unable to convince myself that this is the case. It is difficult, however, on account of the very small size of the animal to come to a satisfactory conclusion. They seem to be five or perhaps seven in number, and simply pinnate, the anterior three being larger than the rest. Back covered with rather distant long soft-looking tubercles, each supported by two or three central spicules which do not project. Extending to the edge of the cloak at intervals are long radial spicules, recalling somewhat in arrangement the ribs of an umbrella.

The ground colour is glistering white, intensified on the branchial and rhinophores and on the median line of the tail. On the back, but not reaching to the margin, is a regular network of reddish crimson, through the meshes of which the white tubercles project. In young specimens the crimson pigment is present in the form of scattered patches between the tubercles. Round the margin of the mantle at a little distance from the edge is a narrow band of lemon yellow. Radula of the type found in Lamellidoris and Goniodoris, with two large median denticles and two small lateral plates.

Goniodoris nodosa (Montagu).

Abundant and spawning on the Black Rocks, February, 1902, and frequently found in other parts. Small specimens (2-6 m.m.) plentiful in Coastguard Deep during October, 1902. No specimens have yet been met with larger than about 1·5 c.m. long, which is much below the size recorded from other places.

Goniodoris castanea (A. & H.).

Two specimens, spawning, on Roeillaun Rocks, February, 1902; one on Ross shore spawning, October, 1902. In both instances the spawn was attached to a piece of Fucus covered with Botryllus.

Idalia aspersa (A. & H.).

Bofin.—One specimen taken amongst weed fragments from clean gravel outside the mouth of the harbour, June, 1899. (E. W. L. H.).

Ancula cristata (Alder).

Bofin.—Two taken in surface townet with floating weed outside mouth of harbour, July, 1900. (M. F. W.)

Ballynakill.—Two colourless specimens, measuring 4 mm. and 6 mm. respectively, dredged in Coastguard deep; one with normal colouration, measuring 9 m.m., from the same spot, October, 1902.

Polycera quadrilineata (Müller).

Bofin, common. Three specimens taken outside the harbour in July, 1899, by Mr. Holt, which were more or less streaked and spotted with dark brown.

Ballynakill, common; especially on a sandy bottom. One specimen with black rhinophores was taken in February, 1902.

Polycera Lessoni (d'Orb.).

Var. *ocellata*, A. and H. Ballynakill, March, 1899. (W. I. B.).

A few very minute specimens (*ca.* 2 mm. long) taken in October, 1902, seemed to belong to the variety.

Triopa clavigera (Müll.).

A few specimens have been taken at various times at Ballynakill.

Ægirus punctilucens (d'Orb.).

Small specimens are fairly common in material dredged from a weedy bottom at Ballynakill. The blue spots are frequently absent from these, and in some cases the brown pigment also.

Pleurophyllidia Loveni (Bergh).

A single specimen dredged south of the Green Rocks in three to four fathoms, January, 1902. (E. W. L. H.).

Dendronotus frondosus (Ascanius).

One large specimen, *ca.* 2 cm. long, was dredged off Ross Point, Ballynakill, in three to four fathoms in May, 1902, and smaller ones have since been taken near the same spot.

Doto fragilis (Forbes).

Occurs occasionally in dredged material, but is never plentiful.

Doto pennatifida (Montagu).

This is the most plentiful Doto in Ballynakill, and it is seldom that a piece of Antennularia is found without one or more specimens upon it. A colour variety which occurs occasionally at Ballynakill, and seems fairly constant, has the body thickly marked with chocolate or purple brown pigment. The papillae are covered with small specks of pinkish brown, close enough to give them a pinkish tint. The tips of the tubercles on the papillae are marked with small clusters of opaque white spots. The hepatic contents are usually of a reddish colour.

Doto coronata (Gmel.).

Not common at Ballynakill, and seldom met with larger than about ·5 cm. long. It does not seem to occur on Antennularia.

Lomanotus marmoratus (A. & H.).

This species has twice been taken in some numbers at Ballynakill, besides which solitary specimens are occasionally met with. In May, 1902, seven specimens were taken on Antennularia in three to four fathoms off Coastguard Bay. These were of a more greyish brown colour than the specimen figured by Alder and Hancock, but they all varied considerably in the shade and depth of colouration, the smaller specimens being paler than the large. The largest measured 2 cm. when extended. On November 1st, 1902, nine specimens were dredged on Antennularia near the same spot. The larger specimens were coloured as in the first lot, but some of the smaller were very pale, and in one which measured 6 m.m. the only pigment present was a little white, densest on the margins of the pleuropodial ridges. The rhinophoral sheath was dentate in all the above instances. The larger specimens often lashed their bodies to and fro, but never attempted to swim by that means.

Lomanotus portlandicus (W. Thompson).

I have followed Mr. Beaumont in ascribing to this species two large specimens of Lomanotus which were taken at Ballynakill in June, 1902. They were both obtained in one haul of a shrimp-trawl off Ross Point in one to two fathoms on a weedy bottom. They measured respectively 5·5 cm. and 4 cm., but seem to have been injured in the trawl and did not stretch themselves to their full extent. They were both of a rich clear reddish colour, paler on the sides and foot. The tips of the rhinophoral sheaths and the margins of the lateral folds were marked with opaque yellow, and the lowest portions of the folds had patches of opaque dirty white. The white pigment was also thinly flecked over the sides, but not in sufficient quantity to produce any appreciable colour effect. The animals seemed soft and flabby in texture, perhaps on account of the injuries they had received. The rhinophores were lamellated and the pleuropodial folds continuous with the deeply cut rhinophoral sheaths.

Æolis papillosa (Linn.).

Found abundantly on Roeillaun Rocks, Ballynakill, in February, 1902, and occasionally in other parts of the harbour.

Common at Bofin. (E. W. L. H. and M. F. W.)

Æolis glauca (A. & H.).

This species was taken abundantly at the mouth of the inner harbour, Bofin, by Mr. Holt in 1899 and 1900. The range of colour in these specimens was from typical through shades of reddish orange to uniform bright red. It would seem probable that Norman's species (*Æ. sanguinea*) is no more than an extreme colour variety of *Æ. glauca*.

Æ. glauca has twice been met with at Ballynakill.

Cuthona peachii (A. & H.).

Has been several times taken at Ballynakill in its usual habitat, *viz.*, on a Hydractinia covered shell inhabited by *Eupagurus Bernhardus*, and has only twice been met with apart from the Hydroid. A large specimen (*ca.* 1·2 cm.), taken in December, 1901, was kept in confinement for a considerable length of time, and grew and flourished in spite of the death of its crab. In the beginning of January it deposited a small neat undulating coil of pink spawn on the shell, and later on other smaller coils. At the end of January two small specimens about 5 mm. long were noticed on the shell amongst the Hydractinia, and about a week later two more measuring *ca.* 2 mm. They grew rapidly, one of the first pair reaching about 1 cm. in March, after which they all died off. They used occasionally to make excursions round the vessel in which they were kept, returning again to the Hydroid.

Cuthona aurantiaca (A. & H.).

A few were taken on the bottom of the Laboratory when she was beached for caulking at Ballynakill in March, 1902.

Cratena viridis (Forbes).

One specimen dredged in Coastguard deep, Ballynakill, in October, and another in November, 1902.

Cratena amœna (A. & H.).

A few specimens have been dredged in Coastguard deep, Ballynakill, during 1902.

Cratena olivacea (A. & H.).

Occurs not uncommonly in dredged material at Ballynakill. One specimen, taken in October, 1902, had fawn-coloured hepatic caeca. All the Ballynakill animals belonged to the form with orange-coloured nuchal streaks.

Tergipes despectus (Johnston).

Plentiful on *Obelia geniculata* from Laminaria growing on the Laboratory a little below the water line, August, 1901. (M. F. W.)

Embletonia (sp. ?)

One specimen was dredged in Coastguard deep in June, 1902. It measured when extended 6 mm. Its body was very narrow,

with two distant anterior pairs of papillae, followed by nine alternate papillae, five on the right and four on the left. The papillae were rather elongate with abruptly truncated transparent tips and brownish-fawn hepatic caecae. The body was flecked with opaque white. Head as in Alder and Hancock's figure of *E. pulchra*. This may perhaps have been a specimen of *E. pulchra*, with which I am not acquainted, but the narrow body and slender truncated papillae do not agree with the description.

Amphorina cœrulea (Montagu).

Frequently met with in dredgings from various parts of Ballynakill Harbour.

Galvina exigua (A. & H.).

Two specimens taken spawning on the thermometer which hangs constantly over the side of the Laboratory, just below the surface, October, 1902.

Galvina tricolor (Forbes).

A few were taken by Mr. Holt in March, 1900, on the bottom of an ice-hulk which was beached at Ballynakill, and I subsequently obtained two specimens, measuring 1·5 cm. and 2 cm. long, off Ross Point, on weedy ground in two to three fathoms.

Galvina picta (A. & H.).

Has not yet been found at Ballynakill, but a few specimens taken by Mr. Holt at Bofin in 1899 from the bottom of a small boat seem, on re-examination, to belong to this species, as they agree closely in colouration, form of the papillae, and radula with Alder and Hancock's figures.

Galvina Farrani (A. & H.).

Specimens with vivid orange spots on the body, ringed with pale blue, similar to those described by Mr. Garstang from Plymouth (Journal Mar. Biol. Assoc., 1890, n.s., Vol. I., p. 483), have been taken by means of a townet dragged through a Zostera bed at Ballynakill in July, 1902, and also on Laminaria from the sides of an ice-hulk.

Galvina vittata (A. & H.).

Four specimens were taken at Ballynakill in March, 1902, on a clump of Antennularia just below low-water-mark. The smaller specimens were pale and faintly marked, as in Alder and Hancock's figure; the largest, which measured 1·9 cm. when extended, dif-

fered in having the brown bands on the papillae broader than the white intervals and the lateral row of blotches very large and distinctly marked. Two small specimens were again taken on Antennularia from Coastguard deep in November, 1902.

Galvina cingulata (A. & H.).

Taken on Fahy Bar, Ballynakill, in March, 1899 (W. I. B.), and also in March, 1901, in the same place.

Coryphella Landsburgii (A. & H.).

Has often been dredged in various parts of Ballynakill Harbour.

Favorinus albus (A. & H.).

Three taken in Bofin Harbour in October, 1900.*
In Ballynakill two were taken in shallow water in Fahy Bay, November 1901; and one was dredged near the mouth of the harbour on a muddy bottom, February, 1902.

Facelina Drummondi (W. Thompson).

Two were dredged near the mouth of Ballynakill Harbour off Freghillaun, January, 1902.

Facelina coronata (Forbes).

In the scrapings of a small boat, Bofin, July, 1899 (E. W. L. H.). Common about stones and rocks near low water at Ballynakill.

Calma glaucoides (A. & H.).

About 60 specimens found at Ballynakill spawning on a patch of eggs of *Gobius niger* in July, 1901; and in July, 1902, the majority of the patches of eggs found had large numbers of the Eolid crawling over them and spawning.

Proctonotus mucronifer (A. & H.).

Three specimens have been dredged at Ballynakill. They were all found amongst dead shells from Coastguard deep in six to eight fathoms. The first, taken in September, 1902, measured 1:3 cm. The second, which measured 9 cm., was kept for a short time, and adopted a curious attitude when at rest. The body of the animal was contracted till it became circular, the papillae being bent

* Also found in the summer of the same year spawning on decaying Algae in the old lobster pond at Bofin. (E. W. L. H.).

so as to radiate horizontally outwards and the rhinosphores laid back along the body. The appearance presented was that of a small expanded Actinian, rather like one which has occasionally been met with on shells from the same grounds (*Sagartia prolifera*?). The dark patch in the centre of the animal's body and the dark brown hepatic caeca, much larger than in Alder and Hancock's figure, increased the resemblance.

The third specimen was small.

The discovery of this species on the West of Ireland is a considerable extension of its distribution, as the only other records that I am aware of are Alder and Hancock's original one from Malahide in 1844, Prof. Haddon's from the same place in 1886 (Proc. Royal Irish Acad. (2) IV., p. 530), and Prof. Herdman's from Lamlash Bay, Arran, in 1880 (Proc. Royal Physical Soc. Edinburgh, Vol. VI.).

Hermæa bifida (Montagu).

First taken at Ballynakill in May, 1899, amongst red algae (E. W. L. H.), and has occurred a few times since in similar situations.

Hermæa dendritica (A. & H.).

Two were taken on *Codium tomentosum* from the Black rocks, Ballynakill, in February, 1902.

Elysia viridis (Montagu).

Small specimens from :5 to 1·5 cm. are frequent in dredgings, but large specimens are very scarce. *E. viridis* was much more abundant in the early spring of 1899 than at any season in subsequent years.

EXPLANATION OF PLATES.

Plate XVIII.

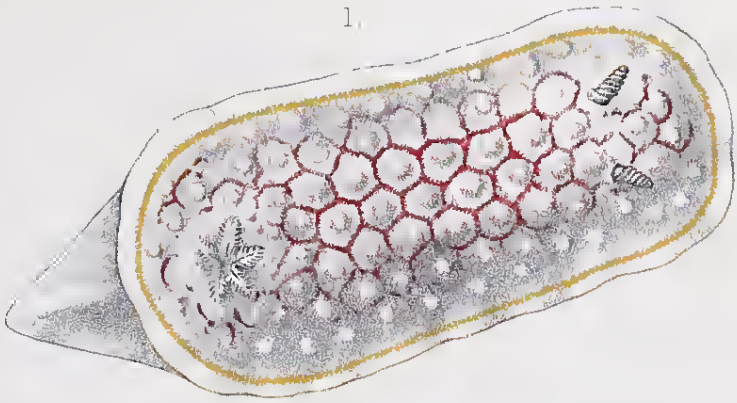
Doris Beaumonti, n. sp.

Fig. 1. Dorsal view, ... × 19
2. Ventral view of head, ... × 27
3. Row of denticles from radula, . . × 430
4. Lateral view of median denticles, . . × 430

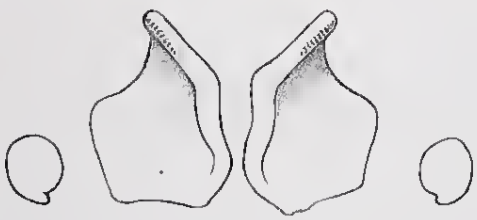
Plate XIX.

Chart of Ballynakill Harbour.

1.



2



3

4

C P F del.
G M Woodward lith

West, Newman imp

Doris Beaumonti n.sp

PLATE XIX

Appendix, No. IX.

ON ROCK-SPECIMENS DREDGED FROM THE FLOOR OF THE ATLANTIC OFF THE WEST COAST OF IRELAND IN 1901.

BY

Grenville A. J. Cole, F.G.S., M.R.I.A., and T. Crook, A.R.C.Sc.I.

Plates XX to XXII.

The specimens placed in our hands were obtained from two localities on the Porcupine Bank, some 130 nautical miles west of the Galway coast, and from three others between this Bank and Erris Head in the County of Mayo. The materials, though showing some signs of attrition in former times, cannot be described as pebbles, and are sometimes distinctly angular. The frequent growths of polyzoa, annelids, and corals upon them show that they are at present in a state of rest at the bottom of the sea.

The interest of such deposits naturally lies in the light that they may throw upon the geological character of a region now covered by the sea. It is necessary to enquire (i.) how far the materials may have been transported by ordinary oceanic currents; (ii.) how far their accumulation may be due to glacial action; and (iii.) how far they are the products of the weathering of rock-masses in their immediate neighbourhood. In the last case, they form our only guides in the geological mapping of the ocean-floor, and may thus assume considerable importance.

Professor David Forbes (1), when describing similar materials from the area between Rockall and Donegal Bay, remarked on their general resemblance to the rocks of north-western Ireland, and was not disposed to invoke glacial action to account for their distribution. He attributed the occurrence of subangular gravel at such depths as 1200 and 1400 fathoms to the "ordinary action of marine currents"; the largest fragment received by him from a depth of 1443 fathoms only weighed 3 grains (0·194 gramme). The materials now placed in our hands from far shallower waters commonly provide fragments 3 cm. in diameter; and the largest mass, brought from the Porcupine Bank, measures 24 by 18 by 11 cm., and weighs 9800 grammes. Where there is a commuuity of character in blocks of these dimensions dredged from any one locality, it seems fair to regard them as an indication of some mass now hidden beneath the sea. This view was urged in connection with Rockall Bank (2), as the result of dredgings made in 1896; and it was then pointed out that the fragments may represent boulders originally formed by subaerial action on the surface of land-masses which have since become submerged.

(1) "Notes on Specimens of the bottom collected during the first Cruise of the Porcupine in 1869," *Proc. Roy. Soc. London*, vol. xviii., p. 490.

(2) "Notes on Rockall Island and Bank," *Trans. Roy. Irish Acad.*, vol. xxxi. (1897), p. 59.

i.

Materials dredged from the Porcupine Bank, depth 90 Fathoms.

Label—Helga LXXVII., 29. vi. '01.

The Porcupine Bank, on which soundings were taken by H.M.S. Porcupine on her first scientific cruise in 1869 (1), lies about 130 nautical miles west of Cleggan in the County of Galway. This spot is convenient as a basis for measurements, since the lines along which other dredgings were made in 1901 radiate from it. The Porcupine Bank is well shown on the Admiralty Chart of the British Islands, the sea-floor rising towards it on the east from a shallow depression between it and Ireland, and falling again far more rapidly on the west down to the 1000-fathom line and truly oceanic waters. The crest of the bank is about 85 fathoms below water, and on the east 185 fathoms are reached in a distance of fifty-three nautical miles, while the same distance on the west brings us to no less than 1600 fathoms (see Plate XXII.). The Porcupine Bank is thus a part of the European plateau, as would be clearly seen were the 300-fathom line taken to indicate the boundary of the ocean, in place of the 100-fathom line commonly adopted. In this it differs from Rockall Bank, which is divided from the British Isles by a channel of deep water. (2) The possible connection of the Porcupine Bank with the lost isle of Brasil has been mentioned by Dr. Frazer (3) in his discussion of an ancient map.

The specimens dredged in 1901 from a depth of ninety fathoms are associated with a "sand" composed to a small degree of minute quartz grains and fragments of rocks similar to those of which larger pebbles are forthcoming, and to a far greater degree of shell-fragments; the latter are water-worn, have a dull surface, and average only 2 mm. in diameter. With these are small fresher molluscan shells and spines of echinoderms. The deposit, in view of the "dead" shells so often found in the North Atlantic, is very probably of two ages, and results in great part from the churning up of an ancient shell-bank.

The large blocks placed in our hands consist of a partly ophitic gabbro of medium grain; they are rounded on all angles and edges, but retain traces of the original joint-planes that bounded them. Their weights in kilogrammes are as follows:—9·8, 7·1, 4·7, 2·3, 2·3, 1·9. With them we received the following smaller stones:—

Gabbro, sometimes decomposed, . . .	1935 stones.
Sandstone, ...	511 „
Fine-grained Biotite-Granite, . . .	1 stone.
„ red Gneiss, ...	1 „

From the considerations already put forward, we conclude that the Porcupine Bank within the 100-fathom line, at the point where this dredging was made, consists of a mass of gabbro, associated with sandstone. The latter is mostly grey and fine-grained, and no veins of the gabbro have been seen in the sandstone pebbles. Nor are the latter, in the ordinary sense, metamorphosed. Their

(1) *Proc. Roy. Soc. London*, vol. xviii. (1869–70), plate 4.
(2) See T. Rupert-Jones, "On Rockall," *Trans. Roy. Irish Acad.*, vol. xxxi. (1897) p. 97.
(3) "On Hy Brasil," *Journ. R. Geol. Soc. Ireland*, vol. v. (1879), p. 128.

superior powers of resistance may, of course, have allowed them to survive as the only representatives of a mingled sedimentary series, the relation of which to the predominant mass of gabbro remains unknown.

In microscopic section (Pl. XX., fig. 1), the gabbro of the Porcupine Bank exhibits in part an ophitic structure. The pyroxene is a yellowish brown, and, in a thick section, one or two grains show the characteristic pleochroism of a rhombic species, associated with the ordinary augite. It is accompanied by some brown biotite; while pale pseudomorphs with blackened cracks and edges represent the original olivine. The felspar is a labradorite verging on andesine. In its degree of decomposition, this rock resembles the gabbros and dolerites of Carboniferous age in Great Britain, rather than the fresher examples from the Cainozoic region of Carlingford or the Inner Hebrides. It may be noted, moreover, that olivine-basalts occur among the products of the Carboniferous volcano of Limerick. (1)

The specific gravity of this gabbro is 3·00.

A section from one of the fine-grained sandstones shows angular grains of quartz and felspar, some of the latter being repeatedly twinned; in addition, we find fairly abundant detrital epidote, some light and dark mica, and one or two pale purple grains which are probably amethyst. The rock, like many "grauwackes" and diabases, is coloured by little films of chlorite, which have developed between the constituents, at the expense of other ferromagnesian minerals. Their source in this case is almost certainly the detrital biotite.

This sandstone resembles the hard rocks, often erroneously styled "grits," that are common in Irish Silurian strata. There is no probability of its having been derived from the decay of the adjacent gabbro, and there is, on the other hand, strong likelihood of its having been formed from the fine-grained gneisses with biotite and epidote that are common in the metamorphic series of north-west Ireland. One such metamorphic rock is figured by us in the present paper (Pl. XXI., fig. 1).

ii.

Materials dredged from the region of the Porcupine Bank' depth 120 Fathoms.

Label—Helga LXXVIII., 29. vi. '01.

This dredging was made outside the eastern edge of the bank, as limited by the 100-fathom line drawn upon the Admiralty Chart of the British Islands. Its distance from the preceding dredging may be as much as thirty nautical miles. A striking change in the predominant rock is apparent. The stones are very little rounded, and some of the granites are quite angular. We received the following:—

Biotite-Granite, sometimes coarse-grained, . .	47 stones.
Aphanite, in some cases with veins of aplitic granite,	13 „
Somewhat fine-grained Diorite or Gabbro, . .	2 „
Sandstone, ...	8 „
Quartzite, ...	1 stone.

(1) M'Henry and Watts, "*Guide to the Collections, Geol. Survey of Ireland*" (1895) p. 94.

The largest of all these stones is a piece of granite weighing only 156 grammes, and measuring some 6 cm. by 5 cm. by 3 cm.

Here, then, granite clearly predominates, and the association of it with aphanite penetrated by granite veins is significant. The granite stones have a yellow-brown exterior, the colour being especially noticeable on the felspars. This is due to a staining spreading from the outside after the formation of the detrital fragments, as is especially well seen in specimens from station "R.T., i., 1D." The colouring is stronger than that which arises during the subaerial weathering of granite, and gives the fragments a superficial resemblance to the brown syenites of Miask in the Urals.

Under the microscope, the granite proves to be rich in microcline; apatite is freely included in the felspar, but also occurs markedly in association with the streaky patches of biotite. Epidote is abundant in these patches, and the arrangement of the ferromagnesian constituent in the mass recalls those rocks of composite origin that are common in north-west Ireland (1). The original granite magma in such a case may have had the composition of aplite, *i.e.*, the "alaskite" magma of Mr. Spurr (2).

In northern Ireland, this magma again and again intrudes into earlier schists and aphanites, belonging to the "Dalradian" series. Off the Porcupine Bank, this series is probably represented by the aphanites and diorites dredged up; but a gneissic type of the granite, which we have studied under the microscope, probably contains much material derived from mica-schists. It is practically a fine-grained biotite-gneiss, with eyes of microperthitic felspar about 7 mm long.. Both epidote and sphene are, as seems usual in composite masses, associated with the long streaks of biotite.

In section, the specimens of aphanite dredged up at this point show both hornblendic and micaceous-hornblendic types, similar to the "epidiorites" of so many metamorphic areas. Sphene occurs at the junction with the aplite veins, and apatite is sometimes abundant. The aplite becomes, as usual, enriched with ferromagnesian material in its passage through the more basic rock. The fact that five out of the thirteen stones classed as aphanite show veins of aplite conspicuous to the naked eye indicates that the site of this dredging is near the margin of the granite mass from which the more abundant type of stone has been derived. (Pl. XX., fig. 2).

The two stones of slightly coarser type, classed as diorite, contain epidote, which almost entirely replaces the felspars in the one selected for microscopic examination.

The sandstones from this dredging show a wide variety, from grey-green types like those described from the Porcupine Bank, to red rocks resembling typical Old Red Sandstone. They imply a considerable extension of sediments in this locality, and bear no signs of penetration or metamorphism by the granite magma.

Judging from our knowledge of the rocks of similar aspect on the west coast of Ireland, we may with much probability picture this side of the Porcupine Bank as consisting of "Dalradian" rocks penetrated by the usual granites, which may be those so

(1) G. Cole, "Metamorphic Rocks in E. Tyrone and S. Donegal," *Trans. R. Irish Acad.* vol. xxxi. (1900), pp. 443 and 447.

(2) *20th Ann. Rep. U. S. Geol. Survey*, pt. vii. (1900), p. 189.

generally associated with the Caledonian folding. Devonian and Carboniferous sediments probably overlie these masses here, as on the mainland; and exposures of unaltered Silurian strata may, of course, also occur, lying between them and the "Dalradians."

iii.

MATERIALS DREDGED FROM A POINT 40 NAUTICAL MILES WEST OF CLEGGAN, CO. GALWAY, DEPTH ABOUT 80 FATHOMS.

Label—Helga LXXXVIII., R.T. iii. 1D., 8. vii. '01.

This dredging was made within the 100-fathom line which marks the edge of the continental plateau, as usually defined. The stones are much more water-worn than those from the region of the Porcupine Bank, and some of them are well-rounded pebbles. Those received by us are as follows:—

Sandstone,	86 stones.
Limestone,	73 „
Biotite-Granite,	29 „
Flint,	4 „
Quartz-rock,	3 „
Diorite,	1 stone.
Decomposed Basalt,	1 „

In addition, we received forty specimens of calcareous organic origin. The only mollusc is *Venus casina*, and the other fragments are colonies of polyzoa.

The largest stone from this dredging is a specimen of granite, measuring 10 cm. by 9 cm. by 5 cm.

Sedimentary rocks are here clearly predominant. The flint is of the Cretaceous type, pebbles of which are found on the shore of Inishbofin, near Cleggan, and in many other places on the west coast. The tiny fragment of basalt probably also represents material drifted from the northern area. The diorite is also a minute fragment. The specimens that represent the locality are granite, stained brown, like that from the eastern edge of the Porcupine Bank, and unmetamorphosed sandstone and limestone The limestone is probably the ordinary grey Carboniferous Limestone, which reaches the sea in the synclinal inlet of Clew Bay, and which formerly extended west towards our area along the more southern synclinal of Bengorm and Muilrea. The limestone fragments are bored through and through by molluscs.

The sandstone for the most part resembles the Lower Carboniferous sandstones of the mainland. A compact greenish specimen was selected for microscopic examination, on account of its different aspect. It consists largely of small angular fragments of altered andesitic lavas, with equally angular quartz-grains. This fact makes the reference of this fine-grained greenish type to Silurian strata all the more probable.

iv.

MATERIALS DREDGED FROM A POINT 30 NAUTICAL MILES WEST OF CLEGGAN, DEPTH 73½ FATHOMS.

Label—Helga CXVII., 23. viii. '01.

This dredging is on the straight line between Cleggan and the last one, but is ten nautical miles nearer to the coast. The sea-floor

was covered with a gravel of small stones, in a ground of fragments of molluscan shells, echinoid tests, and polyzoan colonies. The larger stones picked out from among these give us:—

Limestone,	50 stones.
Sandstone,	17 „
Biotite-Granite,	12 „
Diorite,	2 „ (small).
Basalt (sp. gravity = 3·01),	1 stone.
Chert,	2 stones (small).

The stones are distinctly water-worn, like those from the dredging ten miles farther west, and the limestone pebbles are bored by molluscs. The average size of the stones is only about 3 cm. by 3 cm. by 3 cm.; one of the limestone fragments is, however, exceptionally large for this area, measuring 10 cm. by 7 cm. by 2 cm.

The characters of these materials, then, so closely correspond with those from the preceding station as to render separate description unnecessary. The proportion betwcen the granite stones and the total sedimentary material is almost exactly the same in both cases.

V.

Materials dredged from a point 40 nautical miles N. 22° W. of Cleggan, Co. Galway, depth about 86 Fathoms.

Label—Helga LXXXV., R.T. i. 1D., 5. vii. '01.

This dredging was made some sixteen nautical miles west of the Mullet promontory on the coast of County Mayo. The following large subangular blocks were obtained:—

Fine-grained Biotite-Gneiss, five blocks, weighing respectively 4·1, 3·7, 1·0, 0·6, and 0·4 kilogrammes.

Yellowish current-bedded sandstone, one block, weighing 2·4 kg.

The smaller stones show a preponderance of metamorphosed material; moreover, the total bulk of the representatives of ordinary sediments is far less in proportion than the figures below given would imply; that is to say, the fragments of sandstone, limestone, &c., are on the average smaller than those of schist and gneiss. True pebbles are somewhat rare. We received:—

Fine-grained Gneiss, with Quartz-Schist and Quartzite,	373 stones.
Sandstone, mostly fine-grained,	285 „
Biotite-Granite, Quartz-Diorite, and Diorite,	68 „
Limestone, sometimes with chert,	39 „
Flint of Cretaceous type,	7 „
Rhyolite,	1 stone.

As in the dredging in 120 fathoms ncar the Porcupine Bank, some specimens styled by us granite graduate into the type styled fine-grained gneiss. Some stones of the latter type, again, clearly represent intrusions of the granite magma into an aphanitic series. A gneiss specially selected for examination proves to be virtually a granite rich in strings of biotite and pale well developed epidote. These two minerals are in close association (Pl. XXI., fig. 1). A more typical and flaggy specimen, finer in grain, which fairly represents

some hundreds of the metamorphic rocks dredged up at this point, shows a pale mica interfoliated with quartz and untwinned granular felspar (Pl. XXI., fig. 2). The felspar has a lower refractive index than quartz, and is probably orthoclase. Yellow epidote is abundant in the micaceous bands, and granular apatite occurs. The quartz frequently shows strain-shadows. This rock, which occurs also in large blocks, is very probably the fundamental one of the district, associated with a few amphibolites and aphanites. Judging by occurrences on the mainland, and by one or two obviously composite specimens dredged up, as already mentioned, we may conclude that the modifications of the granite of this area towards hornblendic types result from its interaction with the basic members of this earlier series.

We have, indeed, been compelled to group together the granites and diorites at this point, though the two ends of the series are perfectly distinct. The felspars show the usual orange-brown stain, and the chief external variation among the specimens seems to lie in the amount of hornblende. The specific gravities of thirteen specimens indicate fairly the range of composition:—2·59, 2·63, 2·64, 2·66, 2·68, 2·68, 2·69, 2·69, 2·71, 2·79, 2·84, 2·90, 3·00.

At one end we have Biotite-Microcline-Granites, which may contain no hornblende, even when the specific gravity reaches 2·66. Micropegmatitic intergrowths occur in these between the quartz and microcline. A specimen with a specific gravity of 2·71 shows both biotite and hornblende; sphene and magnetite occur in little clusters. The felspar is partly orthoclase and partly plagioclase; the extinctions of crystals of the latter which are available in our section indicate at least andesine, and Szabó's flame-tests refer the species to labradorite. Zoned specimens show that the composition is not always uniform throughout the crystal. The close resemblance of this rock to the typical Tonalite of Monte Adamello (1) is of interest.

The other end of the series may be represented by a specimen with a specific gravity of 2·90. Here hornblende and felspar are seen distinctly interfoliated, as in many "epidiorites" produced under metamorphic action. The quartz that is seen under the microscope seems to be of secondary origin, but cannot be traced to any granitic intrusion. There is no doubt that this rock, with its abundant hornblende and saussuritic felspars, results from the alteration of a gabbro like that of Oritor in east Tyrone (2).

The enrichment of ordinary granite with hornblende at the expense of gabbros and diorites has been discussed by Lévy, Sollas, and others (3); and, in view of the instances established in the north of Ireland, the variations in the granite and quartz-diorite series represented in the present dredging are very probably due to the interaction of a granite magma with the basic series of the same area.

Signs of strain occur in the crystals in some of the granites of this dredging, as if earth-pressures had acted on them since con-

(1) See Zirkel, "*Lehrbuch der Petrographie*," Bd. ii. (1894), p. 505.

(2) G. Cole, "Geology of Slieve Gallion, Co. Londonderry," *Sci. Trans. R. Dublin Soc.*, vol. vi. (1898), p. 237.

(3) See *ibid.*, pp. 226, 227, and references in "Metamorphic Rocks in E. Tyrone," *Trans. R. I. Acad.*, vol. xxxi., pp. 438 and 439.

solidation. The evidence as a whole, however, is in favour of classing them with the granites that penetrate the metamorphic and "Dalradian" series in the Counties of Sligo, Donegal, Londonderry, and Tyrone.

It is of interest to note that a line joining the site of this dredging and a point intermediate between the two preceding ones, *i.e.*, those west of Cleggan, where similar granites evidently occur, runs in a characteristic "Caledonian" direction, and supports the view that we are here examining merely a submerged portion of north-west Ireland.

The sandstones and limestones of this dredging call for little comment. The Old Red Sandstone type is almost absent; and the occurrence of black chert within some of the limestone fragments goes far in this area to prove their Carboniferous origin.

The one pebble of stony rhyolite seems an obvious stranger. It is well rounded, and is like some of the pebbles that have been borne from the Cainozoic dykes of County Down into the eastern Irish drift. Under the microscope, however, it proves to verge on quartz-andesite, and has much in common with the lavas associated with the Old Red Sandstone in Scotland, and, to a limited extent, in northern Ireland.

In addition to the above, the following large stones were dredged up by the Fishery Survey, in all probability from this locality; we are informed, however, that their exact source is now doubtful:—Aphanite, weight 3·7 kg.; limestone, three blocks, weighing respectively 1·5, 1·4, and 0·17 kg.; sandstone, three blocks, weighing respectively 1·1, 0·55, and 0·25 kg.; and granite, 0·22 kg. One of the limestones is cherty, and the sandstones may also be of Carboniferous age.

vi.

Conclusion.

The results of this examination of dredged materials is far more satisfactory than we should have anticipated, and indicates that a fair conception of the geology of the submarine western plateau may be acquired through the surveys of successive years. Off the west of Mayo and Galway, we seem to be outside the region of Cainozoic volcanic activity, and to find little but submerged masses of the rocks familiar in western Ireland. The exception is the olivine-gabbro of the Porcupine Bank, of which we shall hope to find other outcrops as time goes on; but this igneous mass may possibly be of Palæozoic age. The view of Suess, that the Atlantic basin is here determined by faults cutting across the previous folded structures of the country, is in no way opposed by the observations, so far as they have gone. The evidence gathered from sunken banks of molluscan shells in the region to the north shows how comparatively recent much of the Atlantic submergence may have been. The breaking up of the old basaltic plateau into blocks limited by faults is recorded on the surviving surface of Antrim and Londonderry, and is evidenced, as Sir A. Geikie has urged (1),

(1) "The Tertiary Basalt-plateaux of North-Western Europe," *Quart. Journ. Geol. Soc. London*, vol. lii. (1896), pp. 399–405. Also "Ancient Volcanoes of Great Britain" (1897), vol. ii. p. 447. See also "Rockall Island," *Trans. R. Irish Acad.*, vol. xxxi., p. 59, and Wallich, "North-Atlantic Sea-Bed" (1862), p. 63.

FIG. 1

FIG. 2.

FIG. 1.

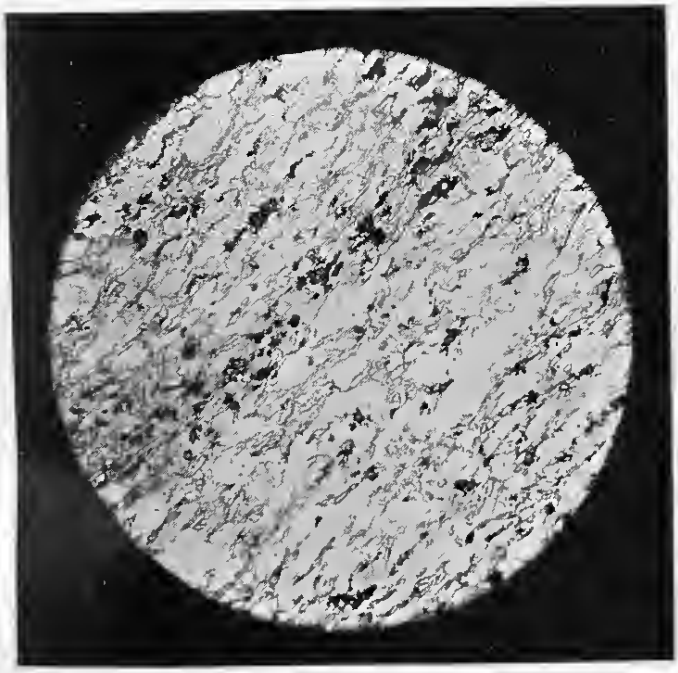
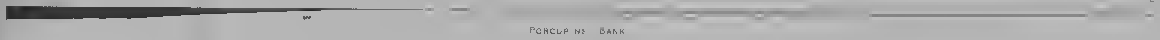


FIG. 2.



by the relics traceable between Ireland and the Færöe Islands. There is much reason to suppose that this faulting is, at the earliest, of Pliocene age; and recently Dr. Nansen (1) has concluded, from a consideration of sunken shell-banks between Iceland and Jan Mayen, that the sea-bottom "during the time of the greatest ice-sheet of Europe, must have been uplifted at least 2,600 metres higher than it is at present." (2). Dr. Brögger is similarly persuaded that in the last interglacial epoch the continental platform stood 100 to 300 metres higher than it does at present. Such conclusions regarding the area to the north cannot fail to affect our views of the settlement of the whole East Atlantic border.

In conclusion, the deposits placed in our hands by the Fishery Survey from the Atlantic coast of Ireland afford an interesting contrast with those recently described by Messrs. Herdman, Dawson, and Clement Reid, (3) from the drift-encumbered sea-floor between Ireland and England. In the latter case, no evidence appears to have been forthcoming as to the nature of the rocks underlying the deposits. The glacial drift still clings to the coast on both sides of the Irish Sea, and its presence suggests that the stones dredged up in that sea had already become well mingled during the Glacial epoch, before they were distributed across the floor of the intervening basin.

(1) In Brögger, "Om de senglaciale og postglaciale nivåforandringer i Kristianiafeltet," *Norges geologiske undersogelse*, No. 31 (1901), pp. 94–96.

(2) Brögger's summary in English, *ibid.*, p. 683.

(3) "Fishes and Fisheries of the Irish Sea," *Lancashire Sea-Fisheries Memoir*, *No.* II. (1902), pp. 10–19.

DESCRIPTION OF PLATES.

PLATE XX. Fig. 1. Microscopic section of olivine-gabbro, Porcupine Bank. Altered olivine is seen near the centre. × 11.

Fig. 2. Microscopic section of granular aphanite (epidiorite) invaded by granite veins, east side of Porcupine Bank. Specimen showing junction of the two rocks. × 11.

PLATE XXI. Fig. 1. Microscopic section of gneiss rich in patches of associated epidote and biotite, 40 nautical miles N. 22° W. of Cleggan, Co. Galway. × 11.

Fig. 2. Microscopic section of fine-grained gneiss from same locality, with pale mica and epidote in foliation-layers. × 11.

PLATE XXII. Section across the Porcupine Bank from the 100-fathom line to oceanic waters. Vertical and horizontal scale the same, so as to show the true form of the sea-floor.

APPENDIX, No. X.

STATISTICAL INFORMATION RELATING TO THE SALMON FISHERIES.

By the courtesy of the gentlemen whose names appear below, it is possible to give the following Returns in continuation of those which appeared in our Report for 1900 (Appendix I., p. 20), and in the Report of the Irish Inland Fisheries Commission (Appendix, Part II., xxiii).*

PERCENTAGES OF WEIGHT OF TAKE ABOVE AND BELOW AN AVERAGE FOR TWENTY-FIVE YEARS ENDING 1899 (*twenty-three years in the case of the Lax Weir Fisheries: twenty-four years, ending* 1894, *in the case of the Laune Fishery*).

Blackwater, Lismore. Mr. R. FOLEY.

1900,	.. ..	40 per cent. below.
1901,	.. ..	57 „ „

Mr. Foley, writes:—"This percentage might have been slightly reduced but for the fact that the Killing Hatch was kept open on agreement with the Earl of Warwick for the first three months; but, as the three spring months of 1900 showed the lowest on record, it could not make much difference."

Blackwater, Co. Kerry. Mr. R. M'CLURE,

1900,	.. ..	.. 30 per cent. below.
1901,	.. ..	.. 42·7 „ „

Waterville, Co. Kerry. Mr. J. E. BUTLER.

1900,	.. ..	.. 46 per cent. below.
1901,	.. ..	.. 48 „ „

Laune, below Killorglin Bridge. Mr. R. POWER.

1900,	.. ..	.. 47 per cent. below.
1901,	.. ..	.. 55 „ „

Lax Weir (including weir and nets), Shannon. Mr. J. A. PLACE.

1900,	.. ..	.. 39 per cent. below.
1901,	.. ..	.. 39 „ „

The return for 1899 was also 39 per cent. below.

Bann Nets. Mr. T. M'DERMOTT.

1900,	.. ..	.. 37 per cent. below.
1901,	.. ..	.. 46·75 „ „

* In connection with the report on Artificial Propagation (page 148, *infra*), the percentages of a number of these fisheries are recapitulated for a series of years.

Foyle Nets. Mr. T. M'Dermott.

1900, ... 45 per cent. below.
1901, ... 39·75 „ „

This slight improvement is noteworthy, as the Foyle Fishery is known to be largely dependent upon peal.

Erne Nets. Mr. T. M'Dermott.

1900, ... 44 per cent. below.
1901, ... 44 „ „

The Return for 1899 was also 44 per cent. below.

Erne, Angling. Mr. T. M'Dermott.

1900, ... 31·25 per cent. below.
1901, ... 38 „ „

Moy, Tidal. Mr. J. Garvey.

1900. .. .. .. Lower than 1901.
1901. .. .. .. 50 per cent. below.

Other Returns.

Suir.—Cahir Park and Neddin's Water. Mr. W. Rochfort.

Cahir Park—

1900, ... 37 salmon, weighing 392 lbs.
1901, ... 24 salmon, weighing 424¾ lbs.

Neddin's Water—

1900, ... 62 salmon, weighing 603 lbs.
1901, ... 23 salmon, weighing 480 lbs.

Mr. Rochfort gives the weights of the largest fish, viz. :—Cahir Park, 32 lbs. (1), 31 lbs. (1), 30 lbs. (1), 29 lbs. (1), 22 lbs. (1), 21 lbs. (1), 20 lbs. (3). Neddin's Water :—35¾ lbs. (1), 29 lbs. (2), 27 lbs. (1), 25 lbs. (1), 24½ lbs. (1), 23½ lbs. (1), 21½ lbs. (2), 21 lbs. (1), 20 lbs. (3).

Comparison of the totals for the two years shows at a glance that while the salmon were fewer in 1901, they averaged much heavier.

Waterville Salmon Fishery. Mr. J. E. Butler.

—	January 1st to 15th.	January 16th to 31st.	February.	March.	April.	May.	June.	July.	Total.
1900, .	31	23	33	9	35	35	86	47	299
1901, .	21	42	25	46	70	15	69	41	329

Blackwater—Dromana Fishery. - Mr. Villiers Stuart.

—	Salmon.	Peal.	Total.
1900, . .	290	480	770
1901, . .	262	220	482

Ownavarra R., Co. Wexford. The Right Hon. The Earl of Courtown

1900, .. Salmon, 15. White Trout, 148.

1901. Lord Courtown writes :—" The run of Salmon showed no marked improvement, but may have been unfavourably affected by the weather. The few salmon that have been taken this season has been much above the average weight of fish taken in the Ownavarra. The run of White Trout showed a considerable improvement."

Castleconnell Angling. Mr. S. C. Vansittart.

—		Salmon.		Peal.		Total for Season, Salmon.	Total for Season, Peal.	Total.
		1st Feb. to 31st May.	1st June to 31st Oct.	1st Feb. to 31st May.	1st June to 31st Oct.			
Worldsend and Erinagh.	1900,	8	5	–	6	13	6	19
	1901,	12	6	–	3	18	3	21
Newgarden, ..	1900,	16	1	–	47	17	47	64
	1901,	30	1	1	66	31	67	98
Summerhill and Castle,	1900,	16	5	–	25	21	25	46
	1901,	14	5	–	9	19	9	28
Woodlands, ..	1900,	12	4	–	4	16	4	20
	1901,	12	2	–	13	14	13	27
Doonass, ..	1900,	14	12	–	38	26	38	64
	1901,	34	12	1	49	46	50	96
Hermitage, ..	1900,	16	10	–	28	26	28	54
	1901,	19	3	–	25	22	25	47
Landscape, ..	1900,*	4	2	–	11	6	1	17
	1901,†	2	2	–	–	4	–	4
Prospect, ..	1900,	13	4	–	27	17	27	44
	1901,	17	5	–	25	22	25	47

* Fished only for a short time in April, May, June, and September.
† Very incomplete.

Mr. Vansittart remarks :—" A very bad season, especially in May."

RETURNS OF IRISH SALMON FROM BILLINGSGATE.

Mr. J. Wrench Towse.

	Number of Boxes of Irish Salmon.		Average Price per lb.		No. of Boxes from all sources.*	
	1900.	1901.	1900.	1901.	1900.	1901.
			s. d.	*s. d.*		
January, ..	32	35	3 10	4 0	94	134
February, ..	168	207	2 7	2 0	637	906
March, ..	303	407	2 5	2 1	1,303	1,530
April, ..	476	580	2 6	2 1	1,548	2,148
May, ..	596	837	1 10	1 7½	2,685	3,651
June, ..	1,011	1,007	1 6	1 5	4,652	4,705
July, ..	1,662	1,383	1 3	1 4	7,805	7,291
August, ..	333	56	1 4	1 4½	3,779	3,576
September, ..	—	2	1 7	1 6	478	663
October, ..	—	—	—	—	46	33
November, ..	—	—	—	—	59	48
December, ..	—	—	—	—	93	70
	4,581	4,514	—	—	23,179	24,755

* Including English, Scotch, Irish, Dutch, Norwegian, German, French, Danish, and Canadian.

APPENDIX, No. XI.

THE RELATIONSHIP BETWEEN SIZE AND SEXUAL MATURITY IN POLLEN.

BY

E. W. L. HOLT.

In continuation of the work of the previous year (see Report for 1900, Appendix, p. 16), I examined a number of pollen taken immediately before and during the spawning season. The fish were sent to me preserved in formaline, by Mr. King, Inspector to the Coleraine Board of Conservators, the dates of capture being a day or so previous to the dates under which they appear in the table given below. I requested that only females at or near the critical size should be sent, but it appears to have been difficult to obtain many of such dimensions. The consignments included a number of males, which for the reason stated in my last report, I have excluded from consideration.

In the table the fish classed as "mature" were either ripe or nearly so. Those classed as "immature" had small ovaries, containing ova too small to develop in the current season, while the presence of fat on the intestines precluded the possibility of recent spawning. One example of $9\frac{1}{4}$ inches, entered as "mature (?)," had ovaries that might possibly, but not probably, have ripened late in the season.

As will be seen neither this table nor that given in my last report affords the slightest indication that pollen are mature at a length of less than eight inches.

FEMALE POLLEN.

Length in Inches.	Condition of Reproductive Organs.	Length in Inches.	Condition of Reproductive Organs.
	18*th November*, 1901.		28*th November*, 1901.
$11\frac{1}{2}$	Mature.	$11\frac{1}{4}$	Mature.
$9\frac{1}{4}$	Mature?	$10\frac{3}{4}$	Do.
$8\frac{3}{4}$	Immature.	$10\frac{1}{8}$	Do.
$8\frac{3}{4}$	Do.	$10\frac{1}{8}$	Do.
$6\frac{1}{4}$ to $4\frac{1}{2}$	Several immature.	10	Do.

FEMALE POLLEN—*continued.*

Length in Inches.	Condition of Reproductive Organs.	Length in Inches.	Condition of Reproductive Organs.
	28*th November*, 1901.		8*th December*, 1901.
9 7/8	Mature.	9 1/2	Mature.
9 3/4	Do.	9 1/4	Immature.
9 1/8	Do.	9 1/2	Do.
9 1/8	Do.	9 1/4	Do.
9	Do.	9 1/4	Do.
8 7/8	Do.	9	Do.
8 3/4	Immature.	8 7/8	Do.
5 3/4	Do.	8 3/4	Do.
5 1/2	Do.	8 5/8	Do.
--	Others smaller, immature.	8 1/2	Do.
	8*th December*, 1901.	8 3/8	Mature.
11	Mature.	7 1/2	Immature.
10 3/4	Do.	7 1/4	Do.
10 1/4	Do.	6 3/8	Do.
10	Immature.	6	Do.
10	Do.	5 1/2	Do.
9 1/2	Do.	5 1/2	Do.

Appendix, No. XII.

REPORT ON THE ARTIFICIAL PROPAGATION OF SALMONIDAE FOR THE SEASON OF 1901–1902.

BY

E. W. L. Holt.

1.—Subsidies.

In my report of 1900 I mentioned a temporary expedient adopted by the Department for subsidising private enterprise in the artificial propagation of salmon during the winter of 1900-1901. Such subsidy was only applicable to hatcheries then in operation, and was conditional on an increase over the output of previous years.

Since then schemes have been formulated for assistance in the erection and maintenance of new hatcheries, where required, and for the enlargement or improvement of existing hatcheries, as well as for the subsidising of existing hatcheries which require neither enlargement nor improvement.

The terms, which have been communicated to Clerks of Conservators for the information of those concerned, are briefly as follows:—

NEW HATCHERIES.

Scheme A.

(1.) In the event of a plan for the erection of a hatchery being approved, and the work carried out to the satisfaction of the Department, the Department are prepared to contribute the cost of erection, subject to the conditions hereinafter expressed.

(2.) The Department would also contribute for a period of ten years a sum equivalent to one-third of the annual cost of maintenance, provided that the remaining two-thirds be guaranteed by the persons locally interested.

(3.) The Department would impose in all cases such conditions as they might see fit in regard to the kind of fish to be reared in the hatchery, supervision by officers of the Department, &c.

(4.) During the above-mentioned period of ten years, as often as the output of fry in any one year should fall below a certain agreed number, the Department would be at liberty to withhold the whole or a part of their contribution towards the cost of maintenance in that year, and the guarantors would be made liable to the Department for a sum not exceeding one-tenth part of the initial cost of erection of the hatchery.

(5.) At the expiration of the above-mentioned period of ten years the entire control of the hatchery would be deemed to have passed into the hands of the Department with a view to their making such arrangements with regard to it as they might think fit.

(6.) The Department reserve the absolute right to make such modifications as they may think fit in the above proposals, so as to meet the particular necessities of individual localities.

Scheme B.

(1.) The Department are prepared to erect and maintain for a period of ten years a hatchery on any river they may consider advisable, if those who are interested in the fisheries of the locality are prepared to contribute to the cost of maintenance in the manner, and subject to the conditions hereinafter expressed.

(2.) An annual contribution should be guaranteed to the Department, by the persons locally interested, of a sum of money equivalent to two-thirds of the estimated cost of maintaining the hatchery, as agreed upon, for the above-mentioned period of ten years.

(3.) Should the guarantors fail to pay the contribution referred to in Clause 2, the Department would be at liberty at its discretion to decrease or entirely cease the output of fry, or to take such legal steps as might be advisable.

(4.) The Department would undertake, during the above-mentioned period, to turn out annually a certain agreed minimum number of fry, unless the contingency in Clause 3 should arise.

(5.) As often as the Department, during the above-mentioned period, should fail to turn out, in any one year, the number of fry referred to in Clause 4, the guarantors would be at liberty to withhold their contribution for that year.

(6.) The Department would reserve the right to transfer ova or fry from any hatchery under their management to any other that might require them, provided, always, that no ova or fry should be so transferred from any river, unless there were available at the time a considerable excess over the minimum number referred to in Clause 4.

(7.) The Department reserve the absolute right to make such modifications as they may think fit in the above proposals, so as to meet the particular requirements of individual localities.

IMPROVEMENT OF EXISTING HATCHERIES.

Scheme A.

1. In the event of a plan for the improvement of an existing hatchery being approved, and the work carried out to the satisfaction of the Department, the Department are prepared to contribute the cost of improvement, subject to the conditions hereinafter expressed.

2. The Department would also contribute for a period of ten years a sum equivalent to one-third of the annual cost of maintenance, provided that the remaining two-thirds were guaranteed by the owner of the hatchery, or others interested.

3. The Department would impose, in all cases, such conditions as they might see fit in regard to the kind of fish to be reared in the hatchery, supervision by officers of the Department, &c.

4. During the above-mentioned period of ten years, as often as the output of fry in any one year should fall below a certain agreed number, the Department would be at liberty in their discretion to withhold the whole or a part of their contribution towards the cost of maintenance in that year, and the guarantors would be made liable to the Department for a sum not exceeding one-tenth part of the cost of improving the hatchery.

5. At the expiration of the above-mentioned period of ten years, should the contribution of the Department be not continued on the above terms, the owners of the hatchery should enter into an undertaking with the Department that the hatchery, having been improved at the expense of the Department, should be used for no purpose other than those sanctioned by the Department.

6. The Department reserve the absolute right to make such modifications as they may think fit in the above proposals, so as to meet the particular requirements of individual localities.

SUBSIDIES TO EXISTING HATCHERIES.

Scheme B.

1. In the case of existing hatcheries on which no capital outlay is required, the Department are prepared, during a period of ten years, to assist their development, with a view to their output being increased, with an annual subsidy, which in no case would exceed one-third of the cost of maintenance.

2. The reasonable annual output of fry from the hatchery, and the reasonable annual cost of maintenance having been ascertained, the Department would pay to the owners a fixed annual sum for every 100,000 fry turned out in excess of an agreed number, provided that in no case should the contribution of the Department exceed one-third of the cost of maintenance.

3. In all cases in which the owner of a hatchery should be in receipt of a subsidy from the Department, the hatchery would be at all times open to the inspection of the officers of the Department, and any suggestion made by the responsible officer of the Department should be carried out.

4. Should the above conditions be at any time not complied with, the Department would be at liberty to cease their subsidy.

5. The Department reserve the absolute right to make any modification they may think fit in the above proposals, so as to meet the particular requirements of individual localities.

In effect, in the case of new or enlarged hatcheries towards which they may think it advisable to contribute, the Department provide all the initial outlay, including the very important item of engineering, and become responsible for one-third of the estimated annual cost of maintenance. The transaction may be regarded as a loan, of which the Department, as representing the public interest, extracts repayment in salmon fry instead of in cash. The clauses which provide for repayment in cash and withdrawal of subsidy become operative only in cases of absolute negligence or mismanagement, and it is the business of the responsible officers of the Department, in approving the plans, to secure an installation which should render the output independent of any contingency, possible to foresee, except neglect or mismanagement. The clauses, however, are absolutely essential, since without such safeguards public money might be wasted in the erection of a hatchery liable to be abandoned as soon as the novelty of the work ceased to interest the owner.

The alternative schemes, under which the Department would become responsible for the management of the hatchery, relieve the guarantor of any liability for repayment of capital expenditure, but, on the other hand, involve on him a much larger annual contribution. Owners of fisheries, who are the class most likely to figure as guarantors (or as representatives of local guarantors) in an agreement respecting a hatchery, are usually also landowners, and, as such, have in their employment a number of servants, whose duties during the winter months are not so engrossing as to prevent their lending a hand in the capture of spawners and in the general work of looking after the hatchery. Such services do not cost the employer very much; whereas the Department, if managing the hatchery, would have to maintain a regular staff employed solely for hatchery purposes, or almost certainly fail in obtaining labour at times when it was absolutely essential.

On this account, while the Department are prepared to establish what may be termed State Hatcheries, as recommended by the Vice-Regal Commission (and innumerable advocates in the daily press), on the production of a sufficient local guaranteed contribution towards maintenance, it is held that equal results may be more economically achieved by the subsidising of private enterprise.

The above schemes refer, nominally, to salmon alone, but in cases where a large public interest can be proved in white trout, or even in brown trout, the Department are not averse to dealing with the artificial propagation of these fish in the same manner.

With regard to the rate of subsidy, a certain margin has to be allowed for differences of local conditions, but in general it appears that salmon fry can be turned down into suitable streams at or about the period of the absorption of the yolk, at a rate of about 4*s.* 6*d.* per thousand, if hatching operations are conducted on a scale sufficiently large to warrant the interest of the Department.

The cost of maintenance is largely determined by the facilities which may exist, within a reasonable distance of the hatchery, for capturing and holding stock fish. If these can be trapped, either in a crib (employed during the open season for commercial purposes), or in some contrivance intended for use in connection with the hatchery alone, the cost is reduced to a minimum. In some instances, however, local conditions render this impracticable, and the choice lies between catching the fish by ordinary legal means towards the end of the open netting season (and impounding them until ripe), and capturing them by some

means or another on the actual spawning redds. As I had occasion to mention in my report for last year, while there may be no great difference in the cost of ova obtained by either of these last methods, the advantages of the former are so manifest as to compel its adoption, even if the more expensive method, wherever trapping is impracticable. The expense, therefore, of a hatchery dependent for its supply of ova on fish obtained in this way must necessarily be greater than that of a hatchery supplied by an automatic trap.

Another circumstance which may materially affect the cost of maintenance is found in the position of the hatchery with regard to the streams and shallows suitable for the enlargement of fry. The selection of the right places for this purpose is perhaps the most important feature in the whole management, since it is worse than useless to hatch fry and then turn them into places where they cannot possibly thrive, and where the output is large, it may often be necessary to cart them long distances at considerable cost. To some extent it may be possible to reduce this expense by transferring the ova when eyed to floating cages moored in the actual streams where the fry are ultimately to be liberated. I shall return to this subject in a later section of this report.

Under the schemes set forth above Mr. Howard St. George's hatchery at Screebe, Co. Galway, has been enlarged to a capacity of over 240,000 fry; Messrs. Dodd and Power's hatchery on the Laune has been transferred from Dunmanaheen to a much more favourable site at Ounagary and enlarged to a capacity of 500,000. Negotiations for the enlargement of Mr. Hall Dare's hatchery at Newtownbarry to a capacity of 2,000,000 may also be expected to result in work on this scale during next winter; and while this report has been in press, a central hatchery for over 2,000,000 has been erected at Lismore, with subsidiary hatching stations in the upper waters of the Blackwater.

Annual subsidies *pro rata* on output have been incurred for the season of 1901-1902 in respect of the hatcheries at Screebe, Cliff, Newtownstewart, Kilrea, Blackcastle, and Skibbereen, and in the case of Lough Neagh, where a large number of professional fishermen are interested in the brown trout fishery, a grant has been made in aid of restocking the Lough with yearlings of the variety known as Loch Levens.

The total amount of the subsidies for the season is about £260 in respect of 2,952,500 salmon, 8,000 white trout, and 20,000 brown trout fry.

ii.—Output and Management.

So far as I can judge the total output for the season 1901-1902 included about 3,333,500 salmon fry, and about 548,000 white trout fry. I make no attempt to estimate the output of brown trout fry (including the variety known as "Loch Levens") since, except in cases where there is an obvious public interest, our dealings with brown trout hatcheries are confined to giving advice, when so required; and there must be many plantings of imported fish or ova of which we do not receive reports.

The following table shows the output from each hatchery. The numbers given in the case of hatcheries marked with an asterisk are based upon estimates made by officers of the Department, the remaining numbers being derived from the reports of owners or managers. In the case of the enclosed redds, which constitute the

hatchery on the Bundrowes, I have, for purposes of comparison, inserted the same number as in my Report for the preceding season.

HATCHERY.	All Salmon.	White Trout.	Foreign Salmon.
Inistioge, River Nore,	†81,000	—	6,000 Scots.
*Skibbereen, River Ilen,	76,500	—	All from Rhine or Weser.
Blackwater (Co. Kerry),	15,000	—	
*Waterville,	20,000	8,000	
*Killarney, River Laune,	48,000	—	
*Killorglin, River Laune,	75,000	—	19,000 Rhine.
*Muckross, River Laune,	67,000	—	
Costello,	—	250,000	
Inver (Co. Galway),	—	250,000	
*Screebe,	235,000	40,000	
Ballysodare,	80,000	—	20,000 Weser
Bundrowes,	36,000	—	
*Belleek, River Erne,	377,000	—	
Glenties, River Owenea,	150,000	—	
Rosses, River Gweedore,	5,000	—	
Glenveagh,	14,000	—	
*Newtown Stewart, River Foyle,	109,000	—	
*Kilrea, River Bann,	650,000	—	
*Blackcastle, River Boyne,	1,295,000	—	
	3,333,500	548,000	

† Includes "the usual number" of native fry, estimated, from inspection last year, at 75,000.

The state of the water during the run of spawners seems, on the whole, to have been more favourable to hatchery work than during the preceding season; but a heavy flood at the critical time prevented the capture of sufficient stud fish to allow of the Glenties hatchery being fully stocked. On the other hand, the increase of 1,114,000 in the output at Blackcastle is entirely due to the more favourable state of the water. This hatchery is supplied by a crib at the end of a diagonal weir a short distance up the Boyne. There are two passes in the weir, and in ordinary water the temporary closure of these passes by means of boards sends enough fish into the crib; but in floods, such as those of the winter of 1900, it is difficult to see how human ingenuity could secure the fish, unless in some of the tributaries. In that winter the floods were so long sustained that they must to a great extent have compensated for the interference with artificial propagation, since high water is more effective than many bailiffs. Thus, on the Shannon, the spawners about Castleconnell were, during that season, never in any danger of human interference. On a small flood river, however, temporary high water, when the spawners are moving, may have

most serious consequences, since such rivers are commonly defective in natural spawning grounds, and in pools where the fish could take refuge when the flood falls. The small output from the Waterville hatchery is due, as appears from Mr. Butler's report, in part to want of funds to support the hatchery, and in part to scarcity of stud fish at the time when they were required. The ova of one fish were successfully fertilised with milt sent by Mr. Power from the Laune, no milter being available at Waterville. Mr. M'Clure, in commenting on the unusually small output from his hatchery on the Kenmare Blackwater, notes that the spawning beds were very well stocked. From the hatchery at Ballysodare Mr. Scott reports that the comparative failure of output was due to scarcity of male fish, while from Rosses Mr. Hanlon records plenty of males but few females. The theory that fish of the two sexes run in separate bodies receives very general belief, and is supported in several instances by methodic observation. It is clearly a point that needs collated investigation in the interests of hatchery work, as well as in view of any measures which may be contemplated for securing a proper breeding stock on the natural redds.

Newtownbarry hatchery was idle on account of the impossibility of obtaining spawners, a defect which, we hope, will be remedied before next season. At Kylemore no hatching seems to have been done, owing to the absence of the owner. Innishannon hatchery was solely used for the propagation of rainbow trout; while at Adare only the native brown trout were dealt with. It is satisfactory to note from Mr. Ballingall's report from the last-named hatchery that his operations have, in five years, completely rehabilitated the Maigue as a brown-trout river. With few exceptions, the fry were retained in ponds up to the yearling stage, and arrangements have now been made to hold fish up to the third year before turning them down in the river.

The difficulty of rearing salmon in ponds to the yearling stage is not much greater than that encountered in the case of brown trout; and, since the whole object of artificial propagation is the protection of the young stages from their natural enemies and from danger of flood or drought, there is no doubt that if equal numbers were handled it would be much more beneficial to safeguard salmon fry for the whole of the first year than to turn them loose as soon as they are old enough to feed.

The pond system, however, entails very considerable expense, in the way of food and skilled labour, and may, not unnaturally, fail to commend itself to persons whose interest in the migratory fish which they rear is not altogether assured. To attempt to rear fry without absolute attention to detail is only to court a mortality not improbably greater than that which takes place under natural conditions; and such operations, which, unfortunately, are not unknown, tend to bring the whole system of artificial propagation into disrepute.

The Department, therefore, in the case of salmon hatcheries over which, in virtue of the subsidy offered, they have assumed a certain control, have confined their action to ensuring the proper handling of the parent fish, the due care of the ova, and the planting of the fry, in as large numbers as possible, in the places most suitable for their future welfare under natural conditions. At hatcheries on large rivers, where a great number of ova are handled, the

expense of distributing the fry in reasonable proportion in the streams and fords is considerable. To a great extent it appears possible to eliminate this charge by making use of floating boxes, of the kinds designed by Herr Jaffé and Mr. Feilding. Herr Jaffé's "Floating Redd," is in essential details a strong box, with ends and sides of perforated zinc, and a raft-like float round the upper circumference. The "redd" is moored in the natural stream* into which it is intended to turn the fry; and the ova, when eyed at the hatchery, are transferred to coarse zinc trays suspended in the "redd." In due course they hatch, and the fry, as soon as they are ready to feed, are released by opening a door at one end of the box.

Mr. Feilding's floating hatchery is similar in general design, but has a coaming above, with solid lid, forming a dark chamber, in which the trays are hung near the surface of the water. The trays are provided with covers, and it appears that the entire period of incubation can, if necessary, be safely dealt with in this apparatus.

Moored in a suitable stream eyed ova placed in the "redd" or floating hatchery require little or no attention: the fry escape the risk of damage in transport, and in sudden transition from the hatchery water to that of a stream, a transition which does not appear to be so harmful to ova, though care must, of course, be taken to gradually alter the temperature of the water in the carriers to that of the stream in which the redds are moored. The expense of carting is reduced by about nine-tenths or more; the risk, with the most ordinary precautions, to *nil.*

If it be desired to protect the fry still further, and the necessary expense and attention can be devoted to the subject, boxes of the same character, but preferably somewhat larger, may be used to retain the fry until the summer, it being understood that regular feeding is necessary from the moment when they will take food. Finely-grated pig's liver seems the most suitable food, administered in small quantities at frequent intervals. All *débris* of food should be carefully covered with earth, and dead fry removed whenever seen. About July the fry must either be liberated or transferred to ponds, and as the fry are strong and active by this time it is doubtful whether the expense and trouble of their further confinement is justified by any material benefit which they would derive from protection.†

Allusion has already been made to the fertilisation of ova by milt sent from a different river, a resource of which advantage may usefully be taken when no local milters are available. Our reports show, however, that this has been done to a rather large scale in cases where no such necessity arose, with a view to the introduction of fresh blood. I do not know that the constant advantage of fresh blood is fully proven even in the case of non-migratory salmonidae; but admitting that it be so, it is matter of common knowledge that salmon are, at least to a small extent, unfaithful to the river of their birth. It follows that fresh blood must be to a corresponding extent introduced without the aid of man. If the process of fertilising with imported milt were invariably as successful as with

* In streams liable to violent floods, some precaution in the way of breakwaters or sluices is advisable. The stability of the "redds" is improved by mooring them in pairs connected fore and aft by stout battens nailed under the floats.

† For details of construction, &c., see Appendix, No. XIV., p. 197.

fresh milt taken on the spot, I should see no reason to criticise the practice; but it was found that, even at the eyed stage, ova treated with imported milt comprised a much higher proportion of dead and unfertilised than the home-milted clutches in the same hatchery. It was claimed that the fry resulting from such cross were finer than the rest; but, supposing this claim to rest on accurate observation, ordinary variation is sufficient to raise a doubt as to whether "*post hoc*" necessarily implied "*propter hoc.*" I think, therefore, that proprietors of hatcheries would be well advised to confine work of this sort for the present to careful experiment on a small scale, including improvement in method of transport of milt and very careful comparison of mortality of ova and character of fry, rather than to risk the loss of large numbers of ova when an ample supply of home-grown milt is available.

A system of hatching which finds a good many advocates, but which is not at present actually practised in this country, calls for a few words. It consists, in effect, in penning pairs of salmon in sections of a natural or artificial stream with a good flow of water and suitable gravelly bottom, and leaving them to deposit their ova in the natural way. The advantage claimed is, I suppose, a close approximation to nature, with the elimination of certain natural risks, such as the destruction of parents by poachers or otters, and of the spawn by birds and trout (I doubt the effectiveness of any grating against eels); and—by sluice-control, of danger from flood or drought. These are serious risks, and it may be further supposed that the male, recognising the futility of any attempt on the domestic arrangements of his neighbours, gives his best attention to his own, instead of leaving his mate (as I have seen under natural conditions) to spawn for protracted intervals alone, while he quarrels with other males. It is, however, at least doubtful whether, given the best attention of the male parent, the percentage of ova fertilised ever approaches that obtainable by artificial methods. Experiment, as between the wet and dry methods, seems clearly to indicate the contrary; while one may also be permitted to doubt whether a natural redd is equally favourable for purposes of oxygenation to all the ova deposited therein. It would therefore seem that this method of propagation, in giving the maximum possible approximation, is also the least possible improvement upon nature; but it is a subject which requires experiment before one can speak with absolute certainty. A modification of this method is in use on one river. The ova are stripped from the fish, artificially fertilised and laid down in hand-made gravel redds enclosed as above. The most serious defect—the risk of non-fertilisation—is, therefore, eliminated, but the handling to which the ova are subjected would appear to be more than is desirable.

A further phase of the method is undoubtedly unsound. The parents having been removed after spawning the ova are left to hatch, and the fry are kept enclosed by fine gratings and expected to find their own food, of which it is supposed that an ample supply is secured by a liberal flow of water. As a matter of fact it is known, from the observations of Dr. Hoek and others, that the natural food of young salmon-fry consists chiefly of insect larvæ, which they obtain from the underside of the stones among which they, the fry, mostly hide in their earlier stages. They feed but

little on water-borne organisms, of which, moreover, there are very few in swift-running streams, the proportion of minute water-borne animals and vegetables being in inverse ratio to the rapidity of the current. It follows that the fry, cooped up in large numbers on limited areas of food-producing ground are subjected to certain starvation.* Thus, while the penning of the parents may be to some extent beneficial, it is mere waste to impound the fry after they are ready to feed.

In conclusion of this section I would call the earnest attention of breeders to the necessity of either providing artificial food or of turning down the fry as soon as they are ready to feed, since it is, I believe, the universal experience that fry which have been more or less starved in their early stages, even for a short period, never make good fish.

iii.—Output Previous to 1901.

Since 1890 returns have been furnished to the Fisheries Office by the majority of persons who have been engaged in artificial propagation, and it seems worth while to recapitulate these returns in the present Report. It must, however, be remembered that the methods of computing numbers at different hatcheries have not been found to be uniform, so that the sum of the returns for any one year may be the sum of amounts deduced by factors of different degrees of accuracy, and, as such, decidedly unreliable. Measuring the ova into vessels of known capacity, as practised at several hatcheries, gives results as nearly approximating to accuracy as can be hoped for, while estimates based on the assumption that a female fish yields so many per lb. of her weight, are, if inaccurate, still fairly comparable *inter se*, provided that the weights are ascertained and not guessed, as is sometimes the case. The method, not wholly unknown to me, of judging the number by the extent to which the ova cover a gravel-filled box requires no comment. The general tendency has probably been in the direction of considerable over-estimation; but I do not think that any general attempt at reduction would, at this date, be useful. The operations at hatcheries from which no reports were received have not, I believe, been of a very important character; but these omissions may to some extent counterbalance over-estimation.

In summarising the returns I have deducted 20 per cent. from the numbers of ova stated to have been laid down, with a view of converting the returns to fry hatched. Such a reduction, I think, errs on the side of moderation. But even an absolutely correct return of fry hatched would be no certain indication of the presumptive efficacy of hatching operations, since many fry are known to have been planted or otherwise disposed of under circumstances which would not seem to make for success.

* The same applies, of course, equally to fry kept in small ponds, and expected to derive the bulk of, if not all, their nourishment from the food supposed to be contained in the water-supply.

[Table

Numbers of Salmon Ova and Fry in Irish Hatcheries during Years 1890–99, inclusive, taken from Returns furnished to the Office of Irish Fisheries.

(The numbers refer to ova, unless otherwise stated.)

——	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
River Liffey,	—	—	—	500 yearlings, 500 2-year-olds.	—	—	—	—	—	—
Newtownharry, River Slaney,	—	—	—	—	110,000	70,000	120,000 fry	210,000	12,000 fry	200,000
Inistioge, River Nore,	—	—	—	—	—	—	—	—	250,000	‖ 187,000
River Suir,	—	7,200 fry	4,000 fry	—	—	—	—	—	—	—
Blackwater, Lismore,	528,000	622,000	300,000 fry	333,000	488,000	416,000	435,000	282,000	Abandoned.	—
Innishannon, River Bandon (Browne, G. C.).	—	—	—	—	—	—	—	—	45,000	—
Innishannon, River Bandon (Frewen, M.).	—	—	—	—	—	—	—	—	40,000	20,000
Skibbereen, River Ilen,	—	—	—	—	—	—	—	—	35,000	35,000
Blackwater, Kenmare,	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	50,000	95,000
Waterville,	—	—	—	—	—	—	—	—	40,000	80,000
Caragh Lake,	—	—	—	—	—	—	—	5,000	—	15,000
Killorglin, River Laune,	—	—	—	—	—	—	—	205,000	—	170,000
Muckross, River Laune,	—	—	—	6,000	66,000	200,000	—	—	55,000	20,000
Adare, River Maigue,	—	—	—	—	—	—	—	—	—	‖ 10,000
Ballinakill (no name),	—	9,000	—	—	—	—	—	—	—	—
Kylemore, River Dawros,	—	—	—	—	—	—	—	42,000	5,000	13,000
Ballysodare,	*130,000	‖ 130,000	100,000 fry	100,000 fry	† 85,000	‡ 112,000	142,000	85,000	45,000	90,000
Cliff, River Erne,	—	420,000	500,000 fry	450,000	840,000	1,000,000	840,000	80,000	175,000	449,000
Glenties, Owenea River,	—	—	—	—	140,000	230,000	250,000	264,000	—	290,000
Rosses,	—	—	—	—	—	—	6,000 fry	{ 30,000 fry 60,000 ova }	§ 80,000	‖ 10,000
Newtown Stewart, River Foyle.	—	—	350,000	480,000 fry	851,000	820,000	810,000	815,000	235,000	674,000
Kilrea, River Bann,	—	—	—	25,000	30,000	—	—	—	1,076	400,000
Blackcastle, River Boyne,	—	—	—	—	80,000	530,000	830,000	500,000	400,000	—
Totals,	758,000	1,281,000 ova 7,200 fry	450,000 ova 904,000 fry	914,000 ova 580,000 fry 1,000 yearlings, &c.	2,790,000	3,478,000	3,407,000 ova 126,000 fry	2,648,000 ova 30,000 fry	1,456,076 ova 12,000 fry	2,758,000

* Including about 20,000 from River Erne. † 10,000 of these ova were lost during early stages of hatching, of which only 150 lived. ‡ This number includes 15,000 Rhine Salmon ova. § Of these but 5,000 hatched out. ‖ Estimated number.

Summary of Output of Salmon Fry, based upon the preceding Return.

1890,	605,400 Fry.	
1891,	1,032,000 „	
1892,	1,264,000 „	
1893,	1,312,200 „	(including 500 yearlings and 500 two-year-olds, River Liffey).
1894,	2,224,000 „	
1895,	2,770,550 „	
1896,	2,851,600 „	
1897,	2,148,400 „	
1898,	1,117,861 „	
1899,	2,206,400 „	

Output of Fry compared with Returns of the Take of Salmon.

Year.	Output of Salmon Fry. Northern Hatcheries. Bann.	Foyle.	Rosses.	Owenea.	Erne.	Ballysodare.	Total.	Total All Irish Hatcheries.	Take of Fish expressed in Ratios to an Average (taken as 100) of 25 Years.* Northern. Bann.	Foyle.	Erne.	Moy.	Bann, Foyle, Erne, and Moy combined.	Southern. Shannon (Lax Weir).	Laune.	Blackwater, Lismore.	Year.
1886	–	–	–	–	–	–	–	–	106	93	93	90	95·5	73	83	108	1886
1887	–	–	–	–	–	–	–	–	99	85	140	121	111·25	122	81	142	1887
1888	–	–	–	–	–	–	–	–	90	121	165	87	115·75	43	118	89	1888
1889	–	–	–	–	–	–	–	–	60	120	100	105	96·25	77	101	142	1889
1890	–	–	–	–	–	104,000	104,000	605,400	67	156	115	142	120·	119	124	142	1890
1891	–	–	–	–	336,000	104,000	440,000	1,032,000	66	157	124	164	127·75	126	112	161	1891
1892	–	280,000	–	–	500,000	100,000	880,000	1,264,000	47	62	97	118	81·	128	153	169	1892
1893	20,000	480,000	–	–	360,000	100,000	960,000	1,312,200	60	95	77	99	82·75	136	95	172	1893
1894	24,000	680,800	–	112,000	672,000	60,000	1,548,800	2,224,000	124	149	124	98	123·75	140	144	169	1894
1895	–	656,000	–	184,000	800,000	77,750	1,717,750	2,770,550	77	140	114	98	107·25	153	110	172	1895
1896	–	648,000	6,000	200,000	672,000	113,600	1,639,600	2,851,600	52	154	93	136	108·75	133	81	115	1896
1897	–	652,000	78,000	211,200	64,000	68,000	1,073,200	2,148,400	38	63	63	53	54·25	62	58	77	1897
1898	861	188,000	5,000	–	140,000	36,000	369,861	1,117,861	33	45	47	55	45·	62	43	62	1898
1899	320,000	539,200	†8,000	232,000	359,200	72,000	1,530,400	2,206,400	51	106	56	67	70·	61	48	66	1899
1900	472,800	256,000	800	216,000	136,400	112,000	1,194,000	2,415,400	63	55	56	?	–	61	53	60	1900
1901	650,000	109,000	4,000	120,000	377,000	64,000	1,324,000	3,333,500	53	60	56	50	54·75	61	45	43	1901
1902	–	–	–	–	–	–	–	–	90·25	68·25	–	105	–	174	–	65	1902

* Twenty-five years ending 1899; 23 years only in the case of the Shannon. The figures from which these ratios are deduced are figures of weight, and not of number.

Inspection of the table of returns received from hatcheries since 1890 shows that artificial propagation has been more concentrated and continuous in the rivers between Portrush and Killala than elsewhere. A glance at the map will show how small a fraction this is of the whole coast line (speaking generally, without regard to small indentations) of the whole country. This is further illustrated by the preceding table, in which the output of ova (less 20 per cent. deduction for mortality) from hatcheries in this area (indicated as "Northern") is contrasted with the total for the whole country. An attempt is also made in the table to compare output of fry with take of fish.

Perhaps the chief value of the table is to illustrate the inadequacy of the information at our disposal. The uncertainty of the value of the returns of number of ova, and of the means adopted in disposing of the fry, are defects which one may hope to eliminate in the course of future work; but there may remain the impossibility of ascertaining what proportion the output of fry may bear to the yield of the fisheries. The returns of fisheries given in the table are merely ratios to an average (taken as 100) for a number of years, furnished to the Inland Fisheries Commission and, in continuation, to the Department, by the proprietors of important fisheries on the rivers indicated. The figures upon which these averages are based are, in most cases, quite unknown to me, nor do I know, except in the most general way, the proportion of the total catch of the river represented by the catch of these particular fisheries. Again, though all the fisheries which appear in the northern group are of great importance, it is not possible to indicate the extent to which one preponderates over another in numerical result. The sum of the ratios is, therefore, the sum of ratios to different values, and the ratio of the least important fishery unduly affects the sum, and *vice versâ*.

Even supposing, however, that we were able to tabulate every fry enlarged under favourable conditions and every fish taken in the nets, I should hesitate (except in the case of a river practically denuded of natural spawning, and not liable, as the present state of our ignorance might suggest, to extensive recruiting from other rivers) to pronounce any but the most general opinion on the effect of a hatchery from the rise and fall of the take. The latter indicates only the number of fish taken, and affords no evidence of the number which, owing to unfavourable weather or during the weekly and annual close times, may have escaped the nets; while it is impossible to assign with certainty to the river of their ultimate destination the victims of, for instance, the very successful drift-net fishery in the open sea off the coasts of Donegal. A sea fishery, even at the very mouth of a river, deals with salmon of no known address; since, as I pointed out in my evidence before the Inland Fisheries Commission, the discontinuance of the net fishing within the half-mile limit of the Waterville river produced no appreciable effect on the return of the weir a hundred yards or so up the river. Again, it is impossible to compute with substantial accuracy the effect of flood or drought on the fry before they descend to the sea.

In the case of one important river I have reason to believe that the average annual take by the principal fishery bears to the average output of fry (which have not always been distributed with conspicuous probability of welfare) a proportion of about one to twenty-seven, or, at any rate, so near such a proportion that the error in

estimate would not materially affect the remarks which follow. Assuming (admittedly without any exact knowledge) that these fry exceed by as much as 60 per cent. the number which would have resulted from the natural spawning of the same parents, the regeneration of the river has been hitherto sought by the enlargement of about twenty-three fry to every fish taken at the mouth of the river, without counting the victims of the drift and other nets outside, and of the anglers and poachers higher up. The total stock in the river is, of course, quite unascertainable, but vastly in excess of the figures represented by the mere catch. However, if the fry liberated had returned one salmon for every 200, and if all of these had been caught in one year, the ratio of the catch would have been raised by only a single unit. I doubt if our present information warrants us in expecting one salmon for every 200 fry, and it goes without saying that whatever be the return it would be distributed over several years, and would in part escape figuring in the catch at all. In fact, the scale of hatching operations has been so small in proportion to the stock of the river that it is only in its cumulative effect (after a number of generations) that its effect could be expected to become sensible; if, indeed, it were not entirely exhausted in combating some adverse natural condition.

It is impossible to pretend at present that our knowledge of the movements of fish at sea is sufficient to afford a basis for an estimate of the circumstances which determine their choice of a river, though we know that at least not all of them are faithful to that of their birth; while it seems certain that "grilse-rivers" are, if one may so term them, for the most part merely "lodgings" for fish which will ultimately seek more spacious quarters. Hatchery rivers may therefore contribute to and receive contributions from other rivers, not necessarily in their neighbourhood, though, as I think our evidence justifies us in believing, most usually so.

The period which may elapse between the deposition of the egg and the descent of the smolt to the sea appears to be from about 1¼ to 3¼ years. About 2¼ years has been held to be the time at which the majority of smolts descend, but it seems not impossible that further research may point to an earlier average migration. Marked smolts are reported to have been retaken as grilse in the summer and autumn of the year during which they descended; but in the few instances in which smolts, marked with an absolutely recognisable object, have been recaptured, the grilse stage has not been reached until the following year. Thus, a fry which appears in the table under 1890 (actually hatched about the middle of February, 1891) might appear in the nets as a grilse in either 1893, 1894 or 1895, or possibly even in 1892, if smolts do actually return in the same year as they descend. The average rate of growth beyond the grilse stage seems to be a matter of absolute uncertainty, since by connecting the evidence afforded by marking experiments it would appear that a fish may take any time from three to ten years (*ab ovo*) to reach 20 lbs.* Some contributors to the literature of the salmon question hold that the fish only seek fresh water once every two years, and although it is positively known that many do return to the river in successive years, it is at least possible that exceptional circumstances may cause a temporary interruption of

* See tables on pp. 76 and 78, Report of Irish Inland Fisheries Commission, Part II

the annual run. The age and previous history of the clean fish which run in winter and early spring in early rivers is also a matter of doubt.

It will be seen, therefore, that there would be the greatest difficulty in ascertaining in what succeeding year the output of a hatchery might be expected to affect a fishery, supposing the number of fry turned down were sufficient to be likely to make any perceptible influence on the catch, which, as I have indicated above, has so far not always, if ever, been the case.

Comparison of the columns of output of fry and of the ratios of the annual to the average take in the same rivers must be admitted to yield only negative results. The rivers, in the period covered by hatching operations, were certainly more productive in the years preceding those in which the results of artificial propagation could possibly have been felt. It is true that the Foyle shows one good take late in the series; but I do not propose to claim this as solely due to hatcheries. In the "northern" rivers of which ratios are shown, I have included several on which there were no hatcheries, while the hatchery returns include several rivers of the takes of which we have no returns. If, in view of the very small numbers hatched, a sensible effect on the take could reasonably be expected, I consider that such knowledge as we possess should lead us to look for it, not necessarily in the individual rivers on which there have been hatcheries, but in the aggregate return for all the rivers of the neighbourhood. Now, for many rivers in the district here called "Northern," we have no returns at all, and of the few that appear in the list, we know that some are much more productive than others, though the details we do not know. Hence the attempt which I have made to combine the returns for this district may have been entirely unsuccessful. Such as it is, it affords no evidence of any effect of artificial propagation.

I have included in the table the three important southern fisheries of which we have returns. The Shannon and (during the period under discussion) the Laune, cannot have been affected by local attempts at artificial propagation. In the later years of the series they show a decline somewhat more marked than the northern hatchery rivers; but I will willingly admit that this greater decline is not necessarily connected with the absence of hatcheries. The Lismore Blackwater shows a slower decline. It was for some years a hatchery river; but the decline begins to be marked during years when the river should still have been receiving recruits from the last years of hatching operations.

We have, therefore, to face the fact that the decline of recent years was general, and that hatchery rivers suffered almost, if not quite, as much as others.

The adverse circumstances, whatsoever they may have been, have therefore produced a practically universal effect, and we are free to admit that artificial propagation, on the scale *and system* on which it has hitherto been conducted has not proved capable of counteracting *in toto* the influence of the said adverse circumstances; though who shall say that the universal improvement of the present year (1902) has not been rendered possible by the cumulative result (small in individual instances) of previous hatchery work?

The advocates of nature will hardly contend that such artificial propagation as has hitherto been carried on could have had any

material influence in reducing the natural available output of healthy fry. Yet if one consults the rise and fall of ratios of take it is at least as difficult as in the case of hatchery outputs to find any connection between good and bad years and their successors. On the whole a good take will be admitted to indicate a bigger run of salmon throughout the year, and consequently a larger number of fish which escape the nets and are available for natural spawning, though exceptionally dry years may favour the nets and exceptionally heavy floods may give the fish a better chance. Yet it is as impossible, as in the case of hatcheries, to connect years of abundant takes with years of subsequent abundance; so if the table shows no conclusive evidence in favour of hatcheries, much less does it go to prove the superiority of natural spawning.

In the spring of 1901 I was on a river where the proprietor had, some years previously, turned down the fry derived from a number of Rhine ova. Unusually large fish were being taken, and the popular mind unhesitatingly ascribed them to Teutonic parentage. In the summer of the same year my colleagues had business there, and fish were very scarce. The local explanation was—"They do be saying 'tis them hatcheries." What "they" have to say about the greatly increased supply of 1902 I have yet to learn.

The fact is, that to attempt to gauge the effect of a hatchery by the return of subsequent years is the merest child's play. We know that the natural conditions of successive years, both in river and sea, are not uniform, and on these depends the fate of the young salmon, whether naturally or artificially hatched. That which, without the slightest doubt, we can do by properly conducted artificial propagation is to increase the number of healthy fry resulting from a given number of ova in the belly of a hen salmon, and to turn down these fry in a situation where they have the best chance of a successful career. Nature must do the rest, and as the increase of the number of fry by artificial propagation can in no way increase the number of natural enemies, nor affect the physical conditions, it must follow that, as the initial number is increased, so will the number of survivors increase.

Opponents of salmon culture appear to freely admit that the benefit of artificial propagation of trout is proven. Until they can prove that smolts derived from hatchery fry are more liable than their brethren to mischance in the sea, this admission appears sufficient to stultify their objections.

APPENDIX, No. XIII.

RECORD OF SALMON-MARKING EXPERIMENTS IN IRELAND,

1898-1902.

BY

E. W. L. HOLT.

Although the period covered by our work is only four years, and the number of records comparatively small, the present occasion appears favourable for the issue of a report, partly on account of the interest which has been manifested on the subject in this country and partly in consequence of the publication of the results of similar experiments in Scotland. (See 20th Annual Report of the Fishery Board for Scotland, Part II., Appendix ii., p. 55).*

It is not my purpose, at the present stage of the investigation, to attempt any but the most tentative interpretation of the results, even in the light of the information afforded by the work of Scotland, Norway, and the United States, since local differences may conceivably affect the habit of the fish to a degree for which we are not prepared.

METHOD.

I am indebted to Mr. Calderwood for the first 2,000 labels issued in Ireland, and none of the patterns which have been used here differ much in shape from the Scottish. The latter (*vide* figure *op. cit.*, p. 72) is of pure silver, and is composed of two pieces soldered together;—a small plate, upon which is stamped a distinguishing number, with a letter; and a wire which is, at its middle, fastened to the unstamped side of the plate, the ends being bent round so as to project at right angles to the plate. To affix the label holes are pierced with a double punch (consisting of strong needles or small punches set at the requisite distance in the head of an ordinary chisel-handle or in a holder specially designed for the purpose) through the thick skin at the base of the dorsal fin (the large fin of the back) as close to the body as may be; the wires are thrust through, crossed and twisted with a pair of pliers. The projecting end formed by the two twisted wires is then pressed close against the base of the dorsal fin in the direction of the tail. The letter and number of the label, being on the side of the plate next to the fin, are not visible until the label is removed. The label, being of plain silver, is a very conspicuous object, and has been found to attract the attention of other fish, as noticed by Mr. Archer in his report upon the Sands' researches.† Mr. Swan, manager of the Erne Fishery at Ballyshannon, who has exceptional opportunities of observation in the holding pond of the Cliff Hatchery, informed me that fish decorated with the plain silver label were persecuted by the attentions of their brethren in captivity. The Cliff holding pond is in effect a large section of a

* *Cf.* also Mr. Archer's Report on Norwegian Experiments. 11th Ann. Report. F. B. Scot., Part II., p. 55.

† *Op. cit.*, p. 62.

branch of the Erne, and, as the habits of the fish therein appear to testify, as near an approach to a natural resting-place of salmon as can be accomplished by artificial means. It seemed, therefore, reasonable to suppose that what happened among fish in the holding pond might equally occur among fish lying in a natural pool of the river. In searching the holding pond in the autumn of 1899, when there was reason to suppose that at least a few fish, marked in the previous season, might be there, I found several which showed healed wounds in the dorsal fin such as might well have resulted from the tearing out of a label. Accordingly, in procuring a fresh stock of labels for use in the winter of 1900-1901, I took the precaution of having them blackened by oxidation. A plain silver label, as our experience shows, becomes slightly darkened by natural causes, but after being worn by the fish for more than a year is still a quite conspicuous object. The oxidised label, on the contrary, by friction of some soil at the edges, becomes more conspicuous after being carried for several months, but remains, in the instances of the longest in use which have come under notice, always less conspicuous than the plain silver. It follows that while less liable to interference in the river or at sea, it is more liable than the plain label to be overlooked on land; but of the two I am disposed to think that the last is the lesser evil.

In 1901 an opportunity occurred of marking fish as they entered the river in the autumn; and, as some considerable proportion of these would be liable to capture in the following spring as slats, it seemed advisable to use a label which could be read without being removed from the fish. It was found to be impossible to stamp the letter and number on both sides of the plate of the Scottish label, and it was not desirable to increase the size of the plate, for fear of undue interference with the freedom of the dorsal fin. I have, therefore, adopted a label which has two plates, between which the wire is soldered, the whole being oxidised. This form is but slightly more bulky than the old single-plate pattern and is fixed in the fish in precisely the same way.

In the returns which follow all labels lettered A are of the Scottish pattern, of plain silver. Labels 1D to 1,000D are of the same shape, but slightly smaller and oxidised, while labels D1,001 and upwards are of the double-plate pattern, oxidised.

It will be seen (p. 168 *infra*) that a larger proportion of oxidised labels used have been returned from recaptured fish than of the plain silver pattern, but as against the theory of the superiority of the black label it may be argued that with each succeeding year of work the operators have become more skilful, and the knowledge of our experiments has become more general among fishermen and dealers. The survival from the winter to the summer of a larger proportion of fish in 1902 than in previous seasons would furnish an explanation perhaps not less probable. The labels are issued in waterproof boxes of 25 or 50 to gentlemen who have the opportunity of using them and are willing to do so (either personally or through employés on whose care and accuracy they can rely). They are arranged in the box, in order of number, on a platform, perforated to receive the wires, the number being written on the tray at the side of each label. A double punch, a pair of pliers, and a wire-lined unshrinkable tape-measure are also supplied. The tape-measure is intended to be nailed to a board on which the fish is laid when being measured. Weighing apparatus is not supplied, as it is always available locally.

The printed directions, of which a copy is given below, are also issued, and information of the existence of the work, by way of printed notice, is circulated as widely as possible.

An honorarium of half-a-crown is offered for the return of labels, with a view to stimulating the interest of professional fishermen, boatmen, ghillies, and the employés of dealers and salesmen; but, in order to prevent false records, no payment is made unless the record is vouched by some one whose *bona fides* in the matter is beyond suspicion; while none is offered except in the case of fish taken by lawful means.

So far, I am happy to say, there has been only one case of a possible attempt at deception, and only two or three cases in which the marked fish possibly came into the hands of their captors by means of which the law might not have approved.

I have pleasure in taking this opportunity of expressing the thanks of the Department to those who have been kind enough to carry out the work of marking. Their names will be found below in the summary of fish marked.

PRINTED FORMS ISSUED.

i.—*DIRECTIONS FOR MARKING SALMON.*

When possible, fish selected for marking should be kept in any convenient enclosure until a sufficient number have been secured.

Three persons should, if possible, be employed in marking them —one to hold and look after the fish; a second to weigh, measure, and mark it; and a third to check and write down the weights and measurements taken by the second, and the number of the label.

The men having taken up their respective stations, the first secures a strop of strong twine round the tail of the fish. He then suspends the fish by the strop to a spring balance. Its weight having been taken, he next lays it on the measure, and its length is measured from the snout to the hollow of the hind edge of the tail. If much exhausted, the fish is then put back in the water for a few minutes; then taken out again and held by the first man while the second attaches the label to it. The label is fixed in the following manner:—Holes are bored with the double punch through the large back-fin as close to the back of the fish as possible; the points of the label are passed through the holes, and are bent towards each other until they touch, when they are twisted two or three times round one another with a pair of pliers; lastly, they are pressed back in the direction of the tail of the fish until the whole lies flat against the fin. The label being fixed, the strop is removed and the fish liberated.

If a fish be caught in one part of a fishery and liberated in another or in an adjoining river, the fact should be entered in the return. If a fish is held in an enclosure for any considerable time between the date of capture and the date of liberation, a note of the time should be entered in the column for Remarks,* and any distinguishing characters, such as wounds, torn fins, or injury to eyes, should also be noted in this column. The state of the fish, whether full, slat or kelt, or clean, should be entered in the column for Condition.

* Forms are issued with columns for particulars, viz., number and letter of label; weight, length and sex of fish; date and place of capture, marking and release; condition and remarks.

ii.—*NOTICE OF REWARD.*

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND.

SALMON FISHERIES.

During the Winter a large number of Salmon were marked on behalf of the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland, with a label attached to the base of the back fin.

A Reward of Two Shillings and Sixpence

is offered for the return of each label, provided that the label is accompanied by particulars of the place and date of capture, the weight, and the length from snout to fork of tail of the Fish from which the label was taken, and provided that the Fish was caught by lawful means.

The label and particulars should be forwarded to

THE SCIENTIFIC ADVISER,

(*Fisheries Branch*),

Department of Agriculture and Technical Instruction for Ireland,

Upper Merrion-street, Dublin.

SUMMARY OF LABELS OF DIFFERENT PATTERNS RECOVERED.

(*Exclusive of those used at Lismore.*)

Number of fish marked with plain silver label, . .	1,113
Number recaptured before leaving the river, . .	6
Number recaptured on return from the sea, . .	11
Number of fish marked with oxidised single-plate label, .	420
Number recaptured before leaving the river, . .	3
Number recaptured on return from the sea, . .	6
Number of fish marked with oxidised double-plate label,	364
Number recaptured before leaving the river, . .	0
Number recaptured on return from the sea, . .	6

SUMMARY OF NUMBERS OF FISH MARKED, 1898–1902.

1898–1899.

River.	Date of Marking.	Total No. Marked	Number of	
			Male.	Female.
Bann—Mr. R. L. Moore, per Mr. T. M'Dermott.	20 : 12 : '98 to 4 : 1 : '99,	15	6	9
Corrib—Mr. T. G. P. Hallett, per Mr. J. Lyden.	10 : 2 : '99 to 9 : 3 : '99,	19	3	16
Erne—Mr. R. L. Moore, per Mr. J. Swan.	22 : 12 : '98 to 9 : 1 : '99,	31	13	18
Foyle—Mr. R. L. Moore, per Mr. T. M'Dermott.	21 : 12 : '98 to 1 : 1 : '99,	28	8	20
		93	30	63

1899–1900.

Ballysodare—Col. Cooper, per Mr. J. Scott.	4 : 1 : '00 to 24 : 2 : '00,	31	25	6
Bandon—Mr. M. Frewen, per Mr. F. Stenning.	8 : 12 : '99 to 7 : 3 : '00,	16	4	12
Bann—Mr. R. L. Moore, per Mr. Thos. M'Dermott.	30 : 12 : '99 to 24 : 1 : '00,	49	30	19
Blackwater (Kenmare)—Mr. R. M'Clure	9 : 12 : '99 to 22 : 12 : '99	14	7	7
Boyne—Mr. R. R. Fitzherbert.	8 : 12 : '99 to 15 : 12 : '99	19	6	13
Burrishoole—Mr. H. M. Anketell-Jones.	12 : 3 : '00 to 11 : 4 : '00,	10	—	—
Caragh—Messrs. R. Power, F. J. Chute, C. O'Brien.	17 : 1 : '00 to 3 : 4 : '00,	38	13	25
Corrib—Mr. T. G. P. Hallett, per Mr. W. N. Milne and Mr. J. Lyden.	29 : 12 : '99 to 17 : 4 : '00,	32	21	11
Pullam—Mr. J. Lyden, ..	18 : 12 : '99, ..	9	6	3
Currane—Mr. J. E. Butler, Major Cresswell, and Mr T. M'Carthy.	14 : 12 : '99 to 19 : 4 : '00,	31	10	21
Erne—Mr. R. L. Moore, per Mr. J. Swan.	8 : 12 : '99 to 28 : 12 : '99,	98	38	60
Foyle—Mr. R. L. Moore, per Mr. J. Swan.	15 : 1 : '00 to 18 : 1 : '00,	54	26	28
Laune—Mr. R. Power, ..	26 : 12 : '99 to 15 : 3 · '00,	33	16	17
Nore—Major E. C. Hamilton,	20 : 12 : '99 to 30 : 12 : '99,	20	8	12
Owenea—Mr. J. A. Pomeroy,	16 : 12 : '99 to 1 : 1 : '00,	49	31	18
Screebe—Mr. H. St. Georgo, per Mr. C. Stanley.	8 : 12 : '99 to 16 : 12 : '99,	45	25	20
Shannon—Mr. J. A. Place and Mr. S. C. Vansittart.	2 : 2 : '00 to 30 : 4 : '00,	30	12	18
Slaney—Mr. R. Hall-Dare, per Mr. J. Sim.	16 : 12 : '99 to 21 : 3 : '00,	40	12	28
Suir—Lord Donoughmore, per Mr. J. Gearon. Mr. Wm. Rochfort.	7 : 2 : '00 to 5 : 4 : '00,	23	5	18
	Total, ..	641	295+	336+

1900–1901.

River.	Date of Marking.	Total No. Marked.	Number of	
			Male.	Female.
Ballysodare—Col. E. Cooper, per Mr. J. Scott.	17 : 1 : '01 to 24 : 1 : '01	30	17	13
Bann—Mr. R. L. Moore, per Mr. Thos. M'Dermott.	17 : 12 : '00 to 30 : 1 : '01,	80	19	61
Blackwater (Kenmare)—Mr. R. M'Clure.	4 : 12 : '00 to 13 : 12 : '00	28	16	12
Burrishoole, —Mr. H. M. Anketell-Jones.	18 : 3 : '01 to 12 : 4 : '01,	15	—	—
Caragh—Mr. C. O'Brien, ..	20 : 1 : '01 to 2 : 3 : '01	20	12	8
Corrib—Messrs. M. Lyden & Son,	2 : 2 : '01 to 29 : 3 : '01,	17	7	10
Currane (Lough)—Major Cresswell.	8 : 2 : '01 to 3 : 4 : '01,	11	2	9
Erne—Mr. R. L. Moore, per Mr. J. Swan.	26 : 12 : '00 to 19 : 1 : '01,	56	22	34
Foyle—Mr. R. L. Moore, per Mr. T. M'Dermott.	12 : 12 : '00 to 11 : 2 : '01,	81	17	64
Launo—Mr. R. Power, ..	17 : 12 : '00 to 15 : 2 : '01,	36	19	17
Lennan—Mr. W. D. Hamilton,	6 : 2 : '01 to 13 : 4 : '01,	9	—	—
Moy—Mr. Geo. Shannon, ..	19 : 2 : '01 to 12 : 3 : '01,	40	—	—
Nore—Major E. C. Hamilton,	22 : 11 : '00 to 18 : 1 : '01,	29	10	19
Owenea—Mr. J. A. Pomeroy, per Mr. H. Wilson.	18 : 12 : '00 to 21 : 12 : '01	50	29	21
Shannon—Mr. S. C. Vansittart,	4 : 2 : '01 to 23 : 4 : '01,	24	7	17
Slaney—Mr. R. Hall-Dare, per Mr. J. Sim.	1 : 12 : '00 to 27 : 3 : '01,	39	8	31
Suir—Lord Donoughmore, per Mr. J. Gearon. Mr. Wm. Rochfort.	8 : 2 : '01 to 27 : 4 : '01,	54	11	43
	Total, ..	619	196+	359+

1901–1902.

River.	Date of Marking.	Total No. Marked.	Number of	
			Male.	Female.
Ballynahinch—Mr. A. Mathews	5 : 3 : '02 to 1 : 4 : '02,	9	2	7
Ballysodare—Mr. J. W. Scott,	15 : 1 : '02 to 25 : 3 : '02,	49	14	35
Bandon—Mr. F. Stenning, ..	15 : 2 : '02 to 25 : 3 : '02,	16	2	14
Bann—Mr. Thos. M'Dermott,	4 : 1 : '02 to 22 : 2 : '02,	128	38	90
Blackwater (Lismore)—Mr. J. Penrose, per Mr J. E. Godfrey.	13 : 10 : '01 to 15 : 1 : '02,	240	97	143
Burrishoole—Mr. H. M. Anketell-Jones.	17 : 3 : '02, ..	3	—	—
Bush—Mr. R. M. Douglas, ..	8 : 2 : '02 to 25 : 3 : '02,	15	7	8
Caragh Lake—Mr. James Moriarty.	17 : 1 : '02 to 18 : 2 : '02,	25	14	11
Erne—Mr. J. Swan, ..	13 : 12 : '01 to 23 : 1 : '02,	80	23	57
Foyle—Mr. Thos. M'Dermott,	1 : 1 : '02 to 14 : 2 : '02,	39	*6	33
Galway—M. Lyden & Sons, ..	3 : 2 : '02 to 14 : 2 : '02,	9	5	4
Killarney, Lower Lake, Rivers flowing into—Mr. James Scully	18 : 12 : '01 to 21 : 1 : '02,	18	8	10
Laune—Mr. R. Power, ..	29 : 11 : '01 to 30 : 12 : '01	10	4	6
Moy—Mr. Geo. Shannon, ..	21 : 3 : '02 to 15 : 4 : '02,	5	—	—
Nore—Major E. C. Hamilton,	28 : 11 : '01 to 4 : 1 : '02,	14	6	8
Owenea—Mr. J. A. Pomeroy, per Mr. H. Wilson.	20 : 12 : '01 to 31 : 12 : '01,	26	6*	19*
Shannon—Mr. S. C. Vansittart,	24 : 2 : '02 to 16 : 4 : '02,	15	2	13
Slaney—Mr. R. W. Hall-Dare, per Mr. J. Sim.	3 : 3 : '02 to 21 : 3 : '02,	39	6+	18+
Suir—Messrs. S. R. Grubb, William Rochfort, and Lord Donoughmore, per Mr. J. Gearon.	1 : 2 : '02 to 26 : 3 : '02,	44	13	31
	Total, ..	784	253+	507+
Grand	Total, 1898 to 1902, ..	2,137	774+	1265+

* Sex of one fish not recorded.

RETURN OF CAPTURES OF MARKED SALMON.

TABLE I.

The Fish entered in this Return were marked after being stripped at Hatcheries, or as Slats taken after natural spawning.

For convenience of reference, the entries are made in numerical order of labels.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	Locality, &c.
	Lbs. oz.	Ft. In.				
3529A	4 8	2 0	Stripped,	Female,	21st Dec., 1898,	Foyle. Sion Mills.
,,	—	—	—	,,	28th Dec., 1898,	,, Castle Gore. Fifteen miles from where liberated Found dead.
3958A	7 0	2 4	Stripped,	Male,	12th Jan., 1900,	Bann. Portna.
,,	—	—	—	,	17th Feb., 1900,	Bann tideway. Two miles below Coleraine. Found dead.
3969A	7 0	2 5	Stripped,	Male,	24th Jan., 1900,	Bann. Portna.
,,	—	—	—	,,	15th March, 1900,	Shore of Lough Neagh. Found dead and covered with fungus.
4039A	5 0	2 2	Stripped,	Female,	13th Dec., 1900,	Blackwater (Kenmare).
,,	9 8	2 2½	Clean,	,,	15th July, 1901,	,, ,, in sweeper net.
4233A	5 0	2 1	Stripped,	Male,	24th Dec., 1900,	R. Laune. (Cottoner's Stream ?)
,,	—	—	—	,,	10th Feb., 1901,	R. Laune. Ballymacprior Found nearly dead.
4234A	6 0	2 3	Stripped,	Male,	24th Dec., 1900,	R. Laune. Meanus.
,,	—	—	Clean,	,,	April, 1901,	,, Castlepool, Meanus.
4238A	6 0	2 3	Stripped,	Female,	28th Dec., 1900,	R. Laune. Meanus.
,,	—	—	Slat,	,,	30th April, 1901,	,, Marraha, Killorglin.

TABLE I.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	Locality, &c.
	Lbs. oz.	Ft. In.				
4456A	4 0	1 10	Stripped (good),	Male, .	15th Jan., 1900,	R. Foyle. Sion Mills.
,,	5 0	2 2	Full (had),	,, .	6th Dec., 1900,	,, ,, Snout broken off where beak had pierced through.
4602A	2 8	1 9	Slat, .	Female,	18th Dec., 1899,	Pullam River. (L. Corrih.)
,,	5 0	—	Clean, .	,, .	End of May, 1900,	L. Corrih.
4629A	4 8	2 3	Slat, .	Male, .	23rd Jan., 1900,	R. Corrib. (At Galway.)
,,	—	—	Slat, .	,, .	Feb., 1900,	Corrib Weir.
4788A	5 0	2 1	Slat, .	Male, .	8th Feh., 1902,	R. Bush. Laggandrade.
,,	6 8	2 3	Clean, .	,, .	2nd May, 1902,	,, Cut Pool.
4926A	6 0	2 1	Stripped,	Female,	2nd Jan., 1902,	R. Erne. Cliff.
,,	8 0	2 4	Clean, .	,, .	18th June, 1902,	,, Ballyshannon.
5302A	4 12	2 1½	Slat, .	—	12th March, 1900,	R. Burrishoole.
,,	8 12	2 4½	Clean, .	—	12th July, 1900,	,,
6920A	4 0	1 7	Slat, .	Male, .	14th Feh., 1901,	R. Suir. Knocklofty.
,,	4 12	2 0	Clean, .	,, .	30th July, 1901,	R. Barrow. Above New Ross.
6988A	4 0	2 0	Slat, .	—	19th Feb., 1901,	R. Moy. Clongee.
,,	6 0	2 0	Clean, .	—	12th July, 1901,	,, Bridge Station, Ballina.
6998A	4 8	2 1	Slat, .	Female,	19th Feb., 1901,	R. Moy. Clongee.
,,	21 0	3 1	Clean, .	,, .	16th June, 1902,	,, Ballina.

TABLE I.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	Locality, &c.
	Lbs. oz.	Ft. In.				
6999A	4 0	2 1	Slat, .	Female,	19th Feb., 1901,	R. Moy. Clongee.
„	16 8	3 0	Clean, .	„ .	22nd May, 1902,	„ Weir, Ballina.
24D	6 0	2 5	Stripped,	Male, .	28th Jan., 1901,	R. Foyle. Sion.
„	11 0	2 6½	Clean, .	„ .	2nd Aug., 1901,	„ Stake net.
47D	5 0	2 3	Stripped,	Female,	14th Jan., 1901,	R. Foyle. Above Sion Mills.
„	—	—	—	„ .	26th Feb., 1901,	„ Below Factory, Sion Mills. Found cut into two pieces.
95D	7 0	2 4	Stripped,	Male, .	1st Jan., 1901,	R. Bann. Portna.
„	7 0	2 3	Slat, .	„ .	9th April, 1901,	„ Bundrowes. Just above tidal portion.
164D	9 0	2 6	Stripped,	Female,	20th Dec., 1901,	R. Owenea. At Glenties.
„	13 8	—	Clean .	„ .	1st June, 1902.	„ On rod and fly.
169D	6 0	2 2	Stripped,	Female,	20th Dec., 1901,	R. Owenea. At Glenties.
„	12 0	2 7	Clean, .	„ .	25th June, 1902,	„ Estuary, in draft net.
537D	11 0	2 9	Stripped,	Female,	19th Dec., 1900,	Owenea, Trihutary of.
„	12 0	—	Clean, .	„ .	5th Aug., 1901,	„ at mouth of. Not weighed.
636D	4 8	2 1	Stripped,	Female,	7th Jan., 1902,	R. Bann. Portna.
„	8 0	2 4	Clean, .	„ .	19th Aug., 1902,	„ New Ferry. 8 miles above Portna.
660D	9 0	2 8	Stripped,	Female	25th Jan., 1901,	R. Laune
„	—	—	Slat, .	„ .	24th May, 1901,	„ Estuary.

TABLE I.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	Locality, &c.
	Lbs. oz.	Ft. In.				
756D	6 8	2 5	Slat, good,	Female,	11th Feb., 1901,	R. Suir. Cahir Park.
„	—	—	—	„ .	25th Feb., 1901,	——
1223D	4 0	2 0	Stripped,	Female,	17th Jan., 1902,	R. Bann. Portna.
„	7 4	—	Clean, .	„ .	About 22nd June, 1902.	R. Bann? See "Field," 4 : 10 : '02.
1250D	5 0	2 1	Slat, .	Female,	18th Jan., 1902,	R. Foyle. Sion.
„	11 0	2 5	Clean, .	„ .	22nd July, 1902,	„ About one mile above Derry.
1252D	4 0	1 11	Full, .	Female,	20th Dec., 1901,	R. Deenagh. Killarney.
„	6 0	—	Clean, .	„ .	25th June, 1902,	Pulta. Half mile below Killorglin Bridge.
1266D	6 0	2 2	Full, .	Male, .	18th Dec., 1901,	Lower Lake, Killarney. (Liberated 24 : 1 : '02.)
„	10 8	2 5	Clean. .	„ .	12th July, 1902,	R. Laune. Below Killorglin Bridge.
1407D	4 0	1 6	Slat, .	Female,	20th Jan., 1902,	Caragh Lake.
„	8 8	2 3	Clean, .	„ .	23rd June, 1902,	Caragh Banks. Sea.
1422D	6 0	2 3	Slat, .	Female,	3rd Feb., 1902,	Caragh Lake.
„	15 0	2 10	Clean, .	„ .	24th June, 1902,	„ Gortnagawn.
1502D	19 0	3 4	Slat, .	Male, .	24th Feb., 1902,	Shaunon. Worldsend.
„	33 0	—	Clean, .	„ .	26th March, 1902,	„ At O'Brien's Bridge. (63 miles from mouth of Shannon.)

Section A.

Stripped Fish and Slats recaptured as Slats before reaching the Sea.

3259 A., Foyle.—Female, marked 21st December, 1898, at Sion Mills; 4 lbs. 8 oz.
Found dead (killed by an otter), 28th December, 1898, at Castle Gore, 15 miles above Sion Mills.

47 D., Foyle.—Female, marked 14th January, 1901, at Sion Mills; 5 lbs.
Found cut in two pieces, below Sion Mills factory, 26th February, 1901.

3958 A., Bann.—Male, marked 12th January, 1900, at Portna (Kilrea); 7 lbs.
Found dead in tideway 2 miles below Coleraine, 17th February, 1900.

3969 A., Bann.—Male, marked 24th January, 1900, at Portna; 7 lbs. Found dead on shore of Lough Neagh, 15th March, 1900.

4233 A., Laune.—Male, marked 24th December, 1900, at Killorglin or on the Cottoner's river (a few miles above); 5 lbs.
Found, nearly dead, at Ballymacprior, 10th February, 1901.

4238 A., Laune.—Female, marked 28th December, 1900, at Meanus; 6 lbs.
Recaptured at Marraha, Killorglin, 30th April, 1901.

660 D., Laune.—Female, marked 25th January, 1901, on the Laune (Killorglin?); 9 lbs.
Recaptured in the Laune estuary, 24th May, 1901.

4629 A., Corrib.—Male, marked 23rd January, 1900, at the Galway angling fishery; 4 lbs. 8 oz.
Recaptured in the weir at Galway, in February, 1900.

756 D., Suir.—Female, marked 11th February, 1901, at Cahir Park; 6 lbs. 8 oz.
Recaptured at or near the same fishery, 25th February, 1901.

Though entered as recaptured before return to the sea, some of these fish, as will be seen by individual records, were retaken in the tideway, and may possibly have reached actual salt water and again passed upwards. The table by no means includes all captures of marked slats, as some, when found in the nets, were released without disturbance of the labels.

All which are tabulated, except 4629 A. and 756 D., are hatchery fish, and it will be noted that two, 3529 A. and 3969 A., proceeded some considerable distance up stream after being relieved of their sexual products. This might be taken as an indication that the *animus* of ascent is not accurately correlated to the need of

reproduction, were it not, perhaps, a habit of slats to retreat up stream after disturbance (*cf.* Calderwood, *op. cit.*, p. 96). All hatchery fish may be taken to have been more or less disturbed in habit by capture and detention pending their use, and within the short period which elapses before their return to the sea it is possible that their habit after release may depart from the normal. The interesting case of the Aensira hatchery slat, which continually descended a formidable fall (a proceeding which is certainly distasteful to normal slats), and again reappeared in the ladder on the same fall (*vide* Calderwood, *ibid.*), is to some extent paralleled by cases which have come under my notice in this country.

The fish for the Newtownstewart hatchery are captured while endeavouring to ascend the Sion Mills weir, are there impounded for a longer or shorter period, and are released after stripping above the weir; but there is a small stream, little more than a ditch, a few yards below the weir which is, at least occasionally, frequented by spawners. The hatchery employés tell me that they have taken a fish from this stream, and stripped and released her above the weir, and that she has again been found after a short interval in the same stream. In this case the fish was recognised by natural marks, probably quite sufficient for men accustomed to handle large numbers.

A more striking instance is afforded by the Glenties hatchery on the Owenea river. The river is formed by two affluents, on one of which is the hatchery. The other is more frequented by fish, which are accordingly trapped there, conveyed about 200 yards over land to the hatchery, stripped, and released in the hatchery affluent. Yet, as has been confirmed by the observation of marked fish, some, at least, of these descend some 600 or 700 yards to the junction of the affluents and appear again in the trap within a short period after their release. Hitherto the fish have been marked with a single-plate label, and as this was not removed, there is no exact record of the time which elapsed between the release of the fish in one branch of the river and their recapture in the other; but this uncertainty will be removed in the future by the use of the double-plate label.

4238 A., a female stripped and released on the 28th December and recaptured on the 30th April, affords the instance, in this section of the table, of the longest sojourn of a slat in the river. This is a 6-lb. fish, but as none of the fish exceed 9 lbs. it is not possible to follow Mr. Calderwood in his observations on the relation between the size of slats and the duration of their stay in fresh water. It will be noted that no slats were recaptured (or at any rate recorded) in any of the smaller rivers in which marking was practised.

The several instances of marked fish found dead or dying have been utilised as evidence unfavourable to artificial propagation; but I do not think that dead slats are so scarce that the demise of three* out of several thousand which have been marked can be taken as proof positive of the deleterious effects of the practice.

* 3529 A and 47 D seem to have been killed respectively by an otter and a mill-wheel.

SECTION B.

Stripped Fish and Slats recaptured as Clean Fish in or at the Mouth of the Rivers, in which they were marked, during the following Summer.

* Denotes fish stripped at hatcheries. The remainder are natural slats.

*4039 A., BLACKWATER (Kenmare).—Female, marked 13th December, 1900; 5 lbs., 2 feet 2 inches.
Recaptured 15th July, 1901; 9 lbs. 8 oz., 2 feet 2½ inches.

*4234 A. LAUNE.—Male, marked 24th December, 1900, at Meanus; 6 lbs., 2 feet 3 inches.
Recaptured at Meanus in April, 1901; weight and length not recorded.

*1252 D., LAUNE.—Female, marked 20th December, 1901, in the Deenagh river, at Killarney; 4 lbs.,† 1 foot 11 inches.
Recaptured in the Laune at Pulta, ½ mile below Killorglin bridge, 25th June, 1902; 6 lbs.

*1266 D., LAUNE.—Male, marked 18th December, 1901 (liberated 24th January, 1902), in the Lower Lake, Killarney; 6 lbs.,† 2 feet 2 inches.
Recaptured in the Laune, below Killorglin Bridge, 12th July, 1902; 10 lbs. 8 oz., 2 feet 5 inches.

1407 D., CARAGH.—Female, marked 20th January, 1902, in Caragh Lake; 4 lbs., 1 foot 6 inches.
Recaptured at Caragh Banks, Castlemaine Harbour, 23rd June, 1902; 8 lbs. 8 oz., 2 feet 3 inches.

1422 D., CARAGH.—Female, marked 3rd February, 1902, in Caragh Lake; 6 lbs., 2 feet 3 inches.
Recaptured in Caragh Lake, 24th June, 1902; 15 lbs., 2 feet 10 inches.

4602 A., CORRIB.—Female, marked 18th December, 1899, Pullam river, Lough Corrib; 2 lbs. 8 oz., 1 foot 9 inches.
Recaptured in Lough Corrib about the end of May, 1899; about 5 lbs.

5302 A., BURRISHOOLE.—Sex unascertained, marked 12th March, 1900, at Burrishoole net fishery; 4 lbs. 12 oz., 2 feet 1¼ inches.
Recaptured at same place, 12th July, 1900; 8 lbs. 12 oz., 2 feet 4½ inches.

6988 A., MOY.—Sex uncertain; marked 19th February, 1901, at Clongee; 4 lbs., 2 feet.
Recaptured at Bridge Station, Ballina, 12th July, 1901; 6 lbs., 2 feet.

† This fish was weighed before stripping.

*4926 A., ERNE.—Female, marked 2nd January, 1902, at Cliff; 6 lbs., 2 feet 1 inch.
Recaptured at Ballyshannon, 18th June, 1902; 8 lbs., 2 feet 4 inches.

*537 D., OWENEA.—Female, marked 19th December, 1900, at the hatchery near Glenties; 11 lbs., 2 feet 9 inches.
Recaptured at the mouth of the Owenea, 5th August, 1901; weight not ascertained, but at least 12 lbs.

*164 D. OWENEA.—Female, marked 20th December, 1901, at the hatchery near Glenties; 9 lbs., 2 feet 6 inches.
Recaptured in the Owenea on rod and fly, 1st June, 1902; 13 lbs. 8 oz.

*169 D., OWENEA.—Female, marked 20th December, 1901, at the hatchery near Glenties; 6 lbs., 2 feet 2 inches.
Recaptured in the estuary, 25th June, 1902; 12 lbs., 2 feet 7 inches.

*24 D., FOYLE.—Male, marked 28th January, 1901, at Sion Mills; 6 lbs., 2 feet 5 inches.
Recaptured in stake net, Foyle Estuary, 2nd August, 1901; 11 lbs., 2 feet 6½ inches.

*1250 D., FOYLE.—Female, marked 18th January, 1902, at Sion Mills; 5 lbs., 2 feet 1 inch.
Recaptured about 1 mile above Derry, 22nd July, 1902; 11 lbs., 2 feet 5 inches.

*636 D., BANN.—Female, marked 7th January, 1902, at Portna; 4 lbs. 8 oz., 2 feet 1 inch.
Recaptured 8 miles above Portna, 19th August, 1902; 8 lbs., 2 feet 4 inches.

*1223 D., BANN.—Female, marked 17th January, 1902, at Portna; 4 lbs., 2 feet.
Received at Billingsgate in the last week of June, 1902, in an Irish consignment; 7 lbs. 4 oz.; length not ascertained.

4788A., BUSH.—Male, marked 8th February, 1902, at Laggandrade; 5 lbs., 2 feet 1 inch (girth, 1 foot).
Recaptured at Cut Pool, 2nd May, 1902; 6 lbs. 8 oz., 2 feet 3 inches (girth, 1 foot 1 inch).

The majority of the fish in this section of the table were taken within reach of the tide, and, since fish appear to present themselves at the mouths of rivers which they do not finally enter, it is not absolutely certain that we are in all cases dealing with a return to the fresh-water haunt of the previous season, though the probabilities certainly point in that direction.

There is only one instance in this list in which the marked fish was detected by a person not being an employé, or associate, of one or other of the gentlemen who have been kind enough to undertake marking operations; and only three instances of this sort among the total of labels recovered. Although we have done our best to circulate information of the existence of marking and of the reward payable for the recovery of labels, I think it is certain that little vigilance is exercised except in the neighbourhood of

places where marking takes place. Hence the inference, that would appear to be justified by our returns, viz., that the large majority of fish return to the rivers that they left during the preceding winter or spring, may not be altogether correct. Such an inference is, however, largely supported by the returns from Scotland, where, owing to its longer duration, the marking experiment is probably much more widely known than in this country.

Apart from its evidence on "homing," this section of the return is chiefly interesting from the light which it may throw upon the rate of growth, and of recovery of condition. In estimating the period of time involved by the change from spent to clean condition we are necessarily hampered by ignorance of the date of leaving fresh water. Thus, the slats 4238A. and 660D. were retaken as slats, and still within the estuary, on the 30th April and 24th May, respectively (see Section A., above), whereas the Bush fish, 4788A., marked as a slat on the 8th February, was clean on the 2nd May. This last is the earliest fish retaken in good condition, having gained 2 inches in length, but only 1 lb. in weight, in the interval of about three months. The Bush, however, is an early river, and (while admitting that available data are far short of proof) I incline to the belief that at least some of our early rivers are temporarily stocked by fish which have not fully recovered condition, and which again visit the sea before returning, in the same year, to fresh water.

The instance of the most rapid recovery te full condition, and of the greatest increase of weight, is afforded by the Caragh fish, 1422D., which increased 9 lbs. in weight, and 7 inches in length in about four and a half months. This means an increment of at least 100 per cent. from the clean weight of the previous season.*

The greatest increase in length is shown by the Laune male, 1407D., which increased 9 inches (and 4½ lbs.) in seven months. or probably less, as it is unlikely that the fish entered fresh water immediately after release.

The least increase in length, *i.e.*, absolutely none, occurs in the case of 6988A, a Moy fish of unascertained sex, which measured the same length, 2 feet, five months after marking, but had gained 2 lbs. in weight.

The fish in this section of the table (except 4602A, of which the clean weight was not exactly recorded) ranged in weight from 4 lbs. to 9 lbs. when marked as stripped fish or slats. Individual weights vary too much, in such a limited number, to permit of the statement of an arithmetical average of increase; but it is quite clear that the gain in weight as between slat and slat, or clean and clean, falls far short of a mean of 100 per cent. If the clean weights be reduced, by the deduction of about one-fifth,† to

* Calderwood (*op. cit.* p. 81) cites the increase of 2 and 3¼ lbs. of 2636 (6¾ lbs.) and 7303 (5½ lbs.) in little over three and a half months as the most striking well-authenticated instances of rapid recovery. I therefore note that 1407D and 1422D, which both show remarkably rapid increase in weight, were weighed as slats and clean fish hy different persons, though I have no reason to doubt the accuracy of either record.

† Calderwood's ohservations (*op. cit.* pp. 98 and 99) of actual decreases deal chiefly with larger fish than ours, and show a loss varying roughly from a seventh to a third.

slat weights, the increase is 100 per cent, in the case of 1422D only. Omitting 4788A for reasons noted above, the least increment from slat to slat (1252D and 6988A), 4 to 6 - $\frac{6}{5}$ (= 4·8) lbs., is 20 per cent.

It is quite impossible, with the small material at our disposal, to enter upon the question of difference of condition in different years.

The place of recapture of 1223D is not certain. The label came into our hands through the courtesy of Mr. F. Napier Sutton, who obtained it from Mr. Palmer, of Billingsgate. Without any knowledge of the origin of the label Mr. Palmer considered that the shape of the fish indicated that it came from the Bann. It reached Billingsgate in a consignment from Ireland.

1250D was recaptured 185 days after being marked. In addition to the label, it was marked by a wide notch, cut far into the adipose or dead fin. I had supposed that such a mark would remain, but when the fish was retaken the fin had recovered its usual form, the outline of the notch being just visible as a faint scar. Tampering with this fin would therefore seem to give no results which would justify the pain it may inflict, and I have therefore asked that the practice, instituted at my request, be discontinued (*cf.* Archer, *op. cit.*, p. 61).

I have expressly omitted from enumeration in this section the record of 1502D, which will be found in the table. The male fish, to which the label 1502D was attached, weighed 19 lbs., and measured 3 feet 4 inches when marked as a rod-caught slat, on the 24th February, 1902, at World's End, Castleconnell, on the Shannon. The label, when returned, purported to have been taken from a fish weighing 33 lbs., caught at O'Brien's Bridge, some miles above Castleconnell, on the 26th March. O'Brien's Bridge is sixty-three miles from the open sea, but only a few miles from the head of the tideway at Limerick. It is not impossible that a fish might have visited the tideway, or even the sea, in the period which elapsed between marking and alleged recapture. Of the *bona fides* of the gentlemen who marked the fish, and by whose good offices the label was returned to the Department, there can be no possible doubt, and far be it from me to suggest any imputation on the fisherman who found the label. The increase in weight is, however, so remarkable, considering the period—about one month—that it seems possible a mistake may have occurred, and I am loth to use the record until confirmed by further results of similar character. Calderwood (*op. cit.*, p. 56) notes a Scottish record of 1845—a slat of 10 lbs. marked with a *zinc** label, and alleged to have been recaptured in less than six weeks, weighing 21¼ lbs. 1502D notwithstanding, I am by no means inclined to quarrel with the query which Calderwood has appended to this record.

* *i.e.*, liable to corrosion in sea-water.

SECTION C.

Stripped Fish recaptured as Full Fish, in the River in which it was marked, during next Spawning Season.

4456 A., FOYLE.—Male, marked 15th January, 1900, at Sion Mills, 4 lbs., 1 foot 10 inches.
Recaptured at Sion Mills, 6th December, 1900; 5 lbs., 2 feet 2 inches.

An increase of something under 1 lb. in weight, and of 4 inches in length from slat to slat. An instance of annual spawning.

SECTION D.

Slats recaptured as Clean Fish, in the River in which they were marked, in the second succeeding Fishing Season.

6998 A., MOY.—Female, marked 19th February, 1901, at Clongee; 4 lbs. 8 oz., 2 feet 1 inch.
Recaptured at Ballina, 16th June, 1902; 21 lbs., 3 feet 1 inch.

6999 A., MOY.—Female, marked 19th February, 1901, at Clongee; 4 lbs., 2 feet 1 inch.
Recaptured at Ballina, 22nd May, 1902; 16 lbs. 8 ozs., 3 feet.

These fish were at large sixteen and fifteen months, respectively. How they occupied themselves during this period there is, of course, nothing to show. They may have passed the winter of 1901-1902 in fresh water, or may have been at sea.

Reducing the clean weights by one-fifth to obtain approximate slat weights, we find that the increase from comparable conditions would be as follows:—

Slat, 1900-1901, . 4·5 lbs.—Slat, 1902-1903, . 15·8 lbs.
„ „ 4 „ „ „ 13·2 „

The increase in weight would therefore be 251 per cent. and 230 per cent., the gain in length being 12 and 11 inches. Reference to Section B will show that among slats retaken as clean fish during the same (or first succeeding) fishing season the weight increment (as between comparable conditions) only once reached 100 per cent., while in both of the instances now before us the average increment in each season exceeded 100 per cent.*

The Moy fish are quite comparable in size to the others of which we have records, and our knowledge would not justify the assertion that they could not have attained so considerable an increment if they had spawned in the winter of 1901-1902. Nevertheless, I am disposed to regard the evidence they present as supporting Archer's contention that some fish do not return to fresh-water, or at least do not develop sexual products, every year. (*cf.* 11th Ann. Rep. Fish. Bd. Scot., Pt. II., p. 68.)

*Compare the other Moy fish, 6988A, marked on the same day, weighing 4 lbs, but, unfortunately for our purpose, of the opposite sex. This fish increased rom slat to estimated slat only 20% in weight in the single season, but as it did ot lengthen at all is perhaps too abnormal for useful comparison.

Section E.

Fish which entered Rivers other than those in which they were marked.

6920 A., Suir.—Male, marked 14th February, 1901, at Knocklofty on the Suir; 4 lbs., 1 foot 7 inches.
Recaptured in the Barrow, above New Ross, 30th July, 1901; 4 lbs. 12 oz., 2 feet.

95 D., Bann.—Male, marked 1st January, 1901, at Portna (Kilrea) on the Bann; 7 lbs., 2 feet 4 inches.
Recaptured in the Bundrowes, just above the tidal portion, 9th April, 1901; 7 lbs., 2 feet 3 inches.

6920 A., a rod-caught slat when marked, does not afford an indisputable instance of change of river, since, when recaptured, it was probably still within reach of the tide, though at least ten miles above the point where the common estuary of the Nore and Barrow unites with that of the Suir to form Waterford Harbour. It was reported as rather brown in colour, but I have taken a river-discoloured white trout several miles from any river.

Salmon are known to move up and down the tideway for some considerable period before they commit themselves to fresh water;* and, four years ago, herring, which would seem to have no special business there, were carried in vast numbers up to the very head of the New Ross estuary. It is therefore possible that 6920A. made no attempt to enter the fresh-water portion of the Barrow, and, since its increase in weight from the slat condition amounted to only ¾ lb., it may have still been feeding; or, alternatively, may be classed as abnormal, and, therefore, unreliable for evidence of habit. Its length increment—5 inches—is, however, by no means below what would appear to be the average. In any case, a change of fresh-water habitat from the Suir to the Barrow would not be of a nature to excite much remark.

95 D., also a male, presents more surprising features. Captured probably at the Cuts, near Coleraine, it was conveyed to Kilrea, and there impounded for hatchery purposes; and marked on the 1st January, after a few days' rest from the fatigues of stripping. Three months and eight days later it was caught by an angler in the Bundrowes, a small but very early river, which drains Lough Melvin into Donegal Bay. The distance, taking no account of indentations of the coast, is about 200 miles. The fish seemed to its captor still a slat, and had increased nothing in weight. By measurements returned to the office it had lost an inch in length, and though this may be due to personal error it is, in the light of Fulton's observations (20th Rep. Fish. Bd. Scot., Part III., p. 342), not impossible, even as between accurate measurements taken from living or recently-killed fish. I neglected, at the time when such information might have been afforded, to ascertain the period which elapsed between death and measurement, so cannot say to what extent the recorded discrepancy may have been due to the known phenomenon of *post-mortem* shrinkage.†

* This was particularly noticed in the Shannon and Lee during the present (1902) season.

† Other instances of apparent loss of length will be found in this report.

The migration of the fish, however, is of more importance than an inch of measurement, and in regard to its entry into the Bundrowes it may be remarked that the mouth of this river presents somewhat peculiar conditions. The estuary, such as it is, ends in a boulder-strewn beach, and fish, nosing, as is their frequent habit, especially at spring tides, up to fresh water on a flood tide,* with no intention of leaving the sea, might find their retreat unexpectedly cut off by the ebb. Hence our fish, though taken in fresh water, may not have been there absolutely of its own volition, but may have been involuntarily driven to take refuge in the Drowes while still seeking recuperation in the sea.

Be this as it may be, it affords no explanation of the circumstances which induced the fish to wander so far from home. We do not know when it left the Bann, and, in the light of other records in this table, it is impossible to say that, for 1901, it remained in the slat condition for an unusually protracted period (*cf.*, 660D., a female). We know only too well that 1901 was a season disastrous to salmon fishermen, and we may suspect that the reason was, in part, to seek in the sea. On such an assumption (based upon no knowledge of the facts and rather negatived, in the region concerned, by the apparent abundance of an important sea food, *i.e.*, herring), we might hold the appearance of a Bann fish in or at the mouth of the Bundrowes to be due to the exceptional scarcity of food nearer home. The fact that salmon do, most usually, return to the river from which they came is, as we have seen, confirmed by the results of all marking experiments,† and the explanation of this phenomenon which must (in our absolute ignorance of the sea habit) find most general acceptation, is to the effect that fish, if they find sufficient food near the mouth of the river which they have left as slats, do not wander very far afield; and on again seeking a *suitable* river are more likely to encounter the one which they came from than another. The conditions which make a river suitable to a particular class of fish are as yet intangible to us.‡ If this be the case our fish had ranged widely beyond the limits of the normal area of marine distribution of Bann fish, which, be it remarked, appear to be held by sea-fishermen to seek the Bann from the east, and not from the west.

We must here consider the possibility of abnormality of habit having been induced by unnatural conditions, viz., impounding at the hatchery, artificial stripping, and marking; and I am indebted to Archer (*op. cit.*, p. 71) for the suggestion that interference with the natural habit of the fish may have a remarkable influence on its future movements. In the majority of cases of marked fish, whether marked as natural slats or as stripped fish detained for a longer or shorter period in the holding ponds of hatcheries, these unnatural conditions do not appear to have produced any marked departure from what would appear to us the normal habit. The

* 95D was caught at the end of springs or heginning of neaps, viz., four days after highest spring.

† We have, unfortunately, no instances of the recapture of fish marked in "grilse-rivers."

‡ The classic instance of the Ballysodare river, which became a salmon river hy the successful engineering of a pass on the previously inaccessihle fall at its mouth would seem to effectually dispose of the theory that the salmon chooses the particular river from which it came and no other.

majority of fish reappeared in the rivers where they were marked, and, if some were recaptured in other rivers, we may note that net-fishermen, accustomed to deal with large numbers, very generally believe that they occasionally recognise in their catch stragglers from other rivers. Whether the popular idea of the distinctive characters of fish of different rivers will survive an exact study of the subject remains to be seen; but we are not at present entitled to affirm that such distinctive characters have no existence in fact.

Among the fish recaptured in rivers at great distances from the place of marking we may first cite the Aensira (Norway) fish, taken 500 miles away from the Aensira river. There is a fall on this river, inaccessible except by a ladder, and all fish mounting the ladder are impounded until the spawning season for purposes of artificial propagation. I know nothing of the pound in which the fish are held, so can form no idea as to how far the detention can be considered an interference with normal conditions. At Cliff, as I have already had occasion to remark, the fish which are diverted by an artificial obstruction into the channel which forms the hatchery holding-pond appear as contented as if they were "potted" in a pool below a natural obstruction. The record of marks placed in Aensira fish, include another case of apparent abnormality of subsequent habit, *viz.*, the fish, already noticed, which, repeatedly released above the fall, as repeatedly descended the fall and again reappeared in the ladder. Other Aensira records do not seem to adduce evidence of interference with the normal habit.

Therefore, while the possibility of interference (with normal habit), due to the circumstances which may have attended marking, should most certainly be borne in mind when an attempt is made to interpret the phenomena exhibited by this method of investigation, I do not think we are at present justified in ascribing great range of migration in marked fish to such circumstances only.

The probable explanation of wide range in the case of fish recovered at great distances after the lapse of years (as was the Aensira fish) is that salmon which, in pursuit of food or otherwise, get beyond the marine sphere of influence of their original river, do not seek to return thereto; but take the first suitable river which presents itself in their new environment, and by cumulative effect of, perhaps, individually small wanderings, in time achieve a considerable migration.*

In the case of clean or full fish seeking a river in which they will propagate (whatever be the impulse directing them thereto), the explanation seems reasonable, however unsupported by any knowledge of the marine habit.

But in such an instance as is afforded by 95D., we are not dealing with a fish which had the potentiality of spawning without further nutriment, but with a lean creature, which could not possibly have matured its sexual products without a return to the feeding grounds. For whatever purpose it ascended the Bundrowes, if voluntarily at all, it could not have been either in connection with reproduction or with a condition of full nutrition. In discussing the results of

* *cf.*, Calderwood, p. 77.

marking at Lismore Weir we shall see that some early fish were, normally or otherwise, only temporary sojourners in the fresh water of that river, while Maxwell's observations on the Cree (see *Field*, 20th April, 1901) afford further evidence of a temporary sojourn in fresh water in the spring and early summer on the part of fish whose movements were undisturbed by human agency. It may therefore be that we have to learn that salmon seek fresh water, not only for reproduction, or on the attainment of a certain condition of nurition (*cf.* Noel Paton, "Life History of Salmon," p. 170), but in connection with other conditions, to which we have, at present, no clue.

On turning to Calderwood's records we find three instances of slats marked in the Helmsdale, and recaptured as clean fish in the Brora. The distance between the rivers is only twelve miles, and the occurrence of such interchange of rivers would seem, perhaps, less remarkable than absolute fidelity. The case of 1733, however, is more in accord with 95D. The fish, a partially stripped male, was released on the 12th December in the Spey and recaptured on the 1st March in the Deveron, still not fully spent, and having lost in the interval 2½ lbs. in weight, and, apparently, 2 inches in length. Another fish, 1647, an unspawned female of 15 lbs., was marked in the Spey on the 14th December, and recaptured as a slat, weighing 14 lbs., in the Dee on the 22nd February. The distance between the two rivers is ninety miles.

It must remain for further investigation, not only by marking, to show whether these instances, and 95D., are to be attributed to the effect of human agency or to some normal phase of the habit of which we are not at present seised.

DURATION OF THE PEAL OR GRILSE CONDITION.

Mr. Calderwood refers (p. 79) to a grilse which remained a grilse eight months after marking, having been to sea in the interval. It may therefore be worth while to note that two Irish fish which were recaptured on their return from the sea and came into the hands of dealers, appear to have been regarded by the latter as grilse. It is possible that size alone is frequently the only criterion used in distinguishing salmon from the grilse; but, as the latter seem to have a somewhat higher trade value, any definite distinction that there may be would probably be familiar to those who are commercially interested in the matter.

FISH MARKED AT LISMORE WEIR AND RECAPTURED.

Hitherto we have dealt with the marking of fish stripped at hatcheries and of slats caught by net or rod in the early part of the open season. The hatchery fish have all been impounded for a longer or shorter period while maturing their sexual products.

In the Lismore experiments the fish were taken in the close season in the weir at Lismore and were detained in the killing-hatch in no case for more than a day, and released above the weir as soon as marked. The majority of them were either full or clean fish, and on this account I have thought it advisable to treat this experiment separately.

The weir is about a mile above the highest point at which the influence of the tide is felt, but I am informed that actual salt water scarcely extends beyond the mouth of the Bride river, some eight or nine miles further down.

I may say that the work was proposed and carried out by Mr. James Penrose, assisted by Mr. J. E. Godfrey and the Messrs. Foley, lessees of the Lismore fishery, the Department's share in the matter being confined to supplying the labels and tools, and giving the necessary permission to fish the killing-hatch in the close season. I mention this, not with a view to disclaiming responsibility, but in order to allocate the credit of the experiment where it is due.

In the table which follows, the records are given in numerical order of labels. With the exception of the first, 4,044A, which was of plain silver, the labels used were of the single-plate pattern, blackened by oxidation.

In nearly all cases the measurements and weights of marking and recapture were taken by the same persons.

TABLE II.

Fish marked at Lismore Weir.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	——
	Lbs. oz.	Ft. In.				
4044A	10 8	2 6	Clean, .	Female,	9th Dec., 1901,	R. Blackwater. Lismore Weir.
„	10 0	—	do., .	do.,	14th Feb, 1902,	R. Blackwater. About one mile above Cappoquin. In nets.
263D	16 0	2 9	No sign of spawn.	Female,	30th Oct., 1901,	R. Blackwater. Lismore Weir.
„	13 8	2 8	Ready to spawn.	do.,	6th Dec., 1901,	R. Blackwater. Lismore Weir. Marked again 384D.
273D	7 0	2 4	Not ripe, .	Male, .	25th Oct., 1901,	R. Blackwater. Lismore Weir.
„	7 0	2 4	Milt running.	do.,	20th Nov., 1901,	R. Blackwater. Lismore Weir. Marked again 347D.
302D	8 8	2 5	Should spawn in 2 weeks.	Female,	1st Nov., 1901,	R. Blackwater. Lismore Weir.
„	8 8	2 5	Ready to spawn.	do.,	12th Nov., 1901,	R. Blackwater. Lismore Weir. Marked again 320D.
333D	3 0	1 10	Milt in 2 weeks.	Male, .	12th Nov., 1901,	R. Blackwater. Lismore Weir.
„	3 0	1 10	Nearly ready to milt.	do.,	21st Nov., 1901,	R. Blackwater. Lismore Weir.
346D	10 0	2 8	Should spawn in 1 week.	Female,	20th Nov., 1901,	R. Blackwater. Lismore Weir.
„	—	—	Slat, .	do., .	3rd Feb., 1902,	R. Blackwater. Careysville Fishery. On rod.
349D	7 0	2 1	Spawning, .	Female,	21st Nov., 1901,	R. Blackwater. Lismore Weir.
„	6 0	2 1	Slat, just spawned.	do., .	7th Dec., 1901,	R. Blackwater. Lismore Weir. Marked again 395D.

Table II.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	—
	Lbs. oz.	Ft. In.				
356D	12 0	2 9	Spawning, .	Female,	22nd Nov., 1901,	R. Blackwater. Lismore Weir.
„	12 0	2 9	do., .	do., .	24th Nov., 1901,	R. Blackwater. Lismore Weir. Marked again 375D.
368D	7 0	2 2	Milting, .	Male, .	22nd Nov., 1901,	R. Blackwater. Lismore Weir
„	About 4 0	—	Slat, .	do., .	14th Feb., 1902,	R. Blackwater. Glenmore. On rod.
371D	6 0	2 2	Should spawn in 1 week.	Female,	24th Nov., 1901,	R. Blackwater. Lismore Weir.
„	6 0	2 2	Spawning, .	do., .	6th Dec., 1901,	R. Blackwater. Lismore Weir. Marked again 388D.
379D	9 0	2 6	Clean, .	Male, .	4th Dec., 1901,	R. Blackwater. Lismore Weir.
„	8 0	—	do., .	do., .	7th Feb., 1902,	R. Blackwater. Between Lismore Bridge and Weir In nets.
393D	30 0	3 0	Clean,	Male, .	7th Dec., 1901,	R. Blackwater. Lismore Weir.
„	24 0	—	do., .	do.,	3rd Feb., 1902,	R. Blackwater. Between Lismore Bridge and Weir. In nets.
395D	6 0	2 1	Slat, just spawned.	Female,	7th Dec., 1901,	R. Blackwater. Lismore Weir.
„ c349D	6 0	2 1	Slat, .	do., .	9th Dec., 1901,	R. Blackwater. Lismore Weir. Marked again 446D.
418D	9 0	2 4	Should milt at once.	Male, .	8th Dec., 1901,	R. Blackwater. Lismore Weir.
„	9 0	2 4	Ready to milt.	do., .	9th Dec., 1901,	R. Blackwater. Lismore Weir. Marked again 444D.

Table II.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	——
	Lbs. oz.	Ft. In.				
425D	4 0	2 0	Milt running.	Male, .	8th Dec., 1901,	R. Blackwater. Lismore Weir.
,,	4 0	2 0	do., .	do., .	9th Dec., 1901,	R. Blackwater. Lismore Weir. Marked again 436D.
426D	29 0	3 0	Clean, .	Male, .	8th Dec., 1901,	R. Blackwater. Lismore Weir.
,,	23 0	—	do., .	do., .	7th Feb., 1902,	R. Blackwater. About one mile above Cappoquin. In nets.
433D	25 0	2 11	Clean,	Female,	8th Dec., 1901,	R. Blackwater. Lismore Weir.
,,	19 0	(2 10)	do.,	do., .	25th Feb., 1902,	Yougbal Bay. In nets.
434D	10 0	2 4	Ready to spawn.	Female,	9th Dec., 1901,	R. Blackwater. Lismore Weir.
,,	About 9 0	—	Slat, .	do., .	4th Feb., 1902,	R. Blackwater. Between Lismore Bridge and Weir. In nets..
552D	18 0	2 9	Clean, .	Male, .	31st Dec., 1901,	R. Blackwater. Lismore Weir.
,,	—	—	—	do., .	24th Jan., 1902,	R. Blackwater. Norrisland. About two miles below Cappoquin. Found dead.
585D	32 0	3 5	Clean, .	Male? .	3rd Jan., 1902,	R. Blackwater. Lismore Weir.
,,	Over 27 0	—	do., .	do., .	4th Feb., 1902,	R. Blackwater. About 1½ miles above Cappoquin. In nets. The Fishermen considered it a ♀ fish.
586D	8 0	2 1	Clean, .	Female,	3rd Jan., 1902,	R. Blackwater. Lismore Weir.
,	8 0	—	do	do., .	1st Feb 1902,	R. Blackwater. Glenmore. 3 miles above Lismore Weir. On rod.

Table II.

No. of Mark.	Weight.	Length.	Condition.	Sex.	Date.	—.
	Lbs. oz.	Ft. In.				
587D	18 0	2 10	Clean, .	Male, .	3rd Jan., 1902,	R. Blackwater. Lismore Weir.
„	15 0	—	do.,	do., .	7th Feb., 1902,	R. Blackwater. About 1 mile above Cappoquin. In nets.
858D	8 0	2 4	Clean,	Female,	11th Jan., 1902,	R. Blackwater. Lismore Weir.
„	10 8	—	do., .	do., .	17th Feb., 1902,	Youghal Harbour. In nets. Sea-lice on this fish.
861D	8 8	2 2	Clean, .	Male, .	11th Jan., 1902,	R. Blackwater. Lismore Weir.
„	9 or 10 0	—	do., .	do., .	19th Feb., 1902,	R. Blackwater. Between Lismore Bridge and Weir. In nets. Sea-lice on this fish.
866D	15 0	2 10	Clean,	Male, .	12th Jan., 1902,	R. Blackwater. Lismore Weir.
„	13 0	—	do.,	do., .	3rd Feb., 1902,	R. Blackwater. Between Lismore Bridge and Weir. In nets.
868D	20 0	3 0	Clean, .	Male, .	12th Jan., 1902,	R. Blackwater. Lismore Weir.
„	18 0	—	do., .	do., .	3rd Feb., 1902,	R. Blackwater. Glenmore. On rod.
870D	5 8	1 11	Clean, .	Female,	12th Jan., 1902,	R. Blackwater. Lismore Weir.
„	About 6 0	—	do., .	do., .	3rd Feb., 1902,	R. Blackwater. Between Lismore Bridge and Weir. In nets.

SECTION F.

Full Fish recaptured before spawning.

333D. Male, recaptured at place of marking nine days later. No change of weight or length.

418D. Male, recaptured at the weir one day later. No change of weight or length.

263D. Female, 16 lbs., 2 feet 9 inches, recaptured at the weir thirty-six days later, having lost 3 lbs. in weight and 1 inch in length.

302D. Female, recaptured at the weir eleven days later. No change of weight or length.

The movements of these fish may be treated with those of the succeeding sections. Otherwise the only noteworthy feature is presented by the female, 263D, which, showing no sign of spawn on the 30th October, was fully ripe on the 6th December. The first entry seems to indicate that, but for the date, the fish might have been regarded as clean.

SECTION G.

Full Fish recaptured when spawning.

273D. Male, recaptured at the weir twenty-six days later. No change of weight or length.

371D. Female. Conditions same as 273D.

SECTION H.

Full Fish recaptured as Slats.

346D. Female, recaptured seventy-five days later, eight miles above the weir. Change of weight and length not recorded.

SECTION J.

Spawners recaptured as Spawners.

425D. Male, recaptured at the weir one day later.

356D. Female, recaptured at the weir two days later.

SECTION K.

Spawners recaptured as Slats.

368D. Male, recaptured eighty-four days later, three miles above the weir, having lost about 3 lbs. (estimated) in weight.

349D. Female, recaptured at the weir, sixteen days later, having lost 1 lb. in weight; length unchanged.*

434D. Female, recaptured a short distance below the weir, fifty-seven days later, having lost about 1 lb. (estimated) in weight.

A comparison of the weights at marking and recapture is interesting, but the materials are as yet insufficient to form a basis for conclusions as to the correlation of time and loss of weight.

In other respects the records in these sections of the table are chiefly interesting in view of the light which they may be supposed to throw upon the question of the effect of marking upon the movements of fish.

In the cases where a considerable time interval elapsed between marking and recapture the *locus* of the fish during the interval must be largely matter of conjecture. Some fish, however, evidently did not get far above the weir; and it may be argued that the operation of marking actually interfered with their ascent. To prove or disprove this is hardly possible, but it can, I think, be shown that there is nothing in the records of recapture inconsistent with the ordinary habits of the fish.

Late-run fish, such as were in all probability the majority of those marked, are not energetic in ascent, and many appear to content themselves with the first stretch of gravelly shoal which they encounter after leaving the sea. This is perhaps more easily observed at Galway than at any other place with which I am acquainted. The ladder on the weir there is, as far as I can judge, negotiable at any stage of the river which I have seen, yet in a dry autumn great numbers of fish make a long pause below it. By the time that spawning commencee most of the fish have passed the weir, but a considerable number, which have had equal facilities for doing so, apparently never make the effort; but breed anywhere between the weir and the fishery offices, which are but a few hundred yards above the tide-head. It is possible that some may have passed the weir and dropped back again from the dead water above it.

At Lismore the river is not suitable for spawning for about two miles above the weir, but just below the latter there is a large stretch of gravelly shallow in the main river, and the approach to the killing-hatch also contains ground frequented by spawners. Full fish released above the weir, finding no suitable ground in the neighbourhood, might not unnaturally drop back through the King's Gap to the shallows below the weir. Once arrived on the killing-hatch shoal and driven thence by previous occupants or disturbed by otters (which do not seem to be scarce there), or even if only still seeking a mate or a spare patch of gravel, a few yards would take the fish again into the hatch.

* This fish, as 395D, was again recaptured at the weir two days later.

SECTION L.

Clean Fish recaptured as Clean Fish.

The total number of clean fish marked between 1st December, 1901, and 15th January, 1902, was 72, viz.:—31 males and 41 females.

The following were recaptured:—

379D. Male, marked 4th December; recaptured sixty-five days later a few hundred yards below the weir, having lost 1 lb. in weight.

393D. Male, marked 7th December; recaptured fifty-eight days later a few hundred yards below the weir, having lost 6 lbs. in weight.

426D. Male, marked 8th December; recaptured sixty-one days later about 3¼ miles below the weir, having lost 6 lbs. in weight.

552D. Male, marked 31st December; "found dead" twenty-four days later about 6¼ miles below the weir.

585D. Male or female? Marked 3rd January; recaptured thirty-two days later about 2¾ miles below the weir, having lost less than 5 lbs. (estimated) in weight.

861D. Male, marked 11th January; recaptured (with sea-lice) thirty-nine days later about 200 yards below the weir, having gained 1 or 2 lbs. (estimated) in weight.

866D. Male, marked 12th January; recaptured twenty-two days later about 200 yards below the weir, having lost 2 lbs. in weight.

868D. Male, marked 12th January; recaptured twenty-two days later three miles above the weir, having lost 2 lbs. in weight.

433D. Female, marked 8th December; recaptured seventy-nine days later in Youghal Bay (about 19 miles below the weir), having lost 6 lbs. in weight and 1 inch in length.

4044A. Female, marked 9th December; recaptured sixty-seven days later in estuary, about 3¼ miles below the weir, having lost ½ lb. in weight.

586D. Female, marked 3rd January; recaptured twenty-nine days later 3 miles above the weir, with no change of weight.

858D. Female, marked 11th January; recaptured (with sea-lice) thirty-seven days later in Youghal Harbour (about 18 miles below the weir), having gained 2 lbs. 8 ozs. in weight.

870D. Female, marked 12th January; recaptured twenty-two days later, about 200 yards below the weir, having gained about 1 lb. (estimated) in weight.

It is worthy of note that none of these clean fish were recaptured in the weir, in which respect they contrast forcibly with the spawners. It would appear, therefore, that if the operation of marking had any effect upon their subsequent movements it affected the two classes differently. This would not be unnatural, since, if we assume that some fish of both classes were frightened down stream or otherwise induced by their experience at the weir to descend the river, the *nisus generativus*, which might impel the speedy re-ascent of the spawners, would not be present in the clean fish.

I imagine, however, that the records will not be held to be indicative of any interruption with the normal habit. It has long been believed at Lismore that the winter clean fish do not remain in the river until the following spawning season, but make only a temporary stay, appearing again in the lower reaches of the river in early spring as "droppers" from whatever point they may have reached in their ascent.

The records certainly favour the correctness of this belief. Only two fish, 586D and 868D, were retaken above the weir, both in February. The former does not appear to have changed in weight in the interval of twenty-nine days, while the latter had decreased by one-tenth in twenty-two days. Both were taken on the rod at Glenmore, three miles above the weir, and may or may not have been dropping back to the sea from some higher point. The remainder were caught in nets* at various points from the first netting station below the weir to the sea at Youghal during February.

It will be seen that nearly all these fish have lost weight. The exceptions are:—861D, retaken fresh from the sea, with increase of a pound or two, after thirty-nine days; 870D, retaken below the weir, twenty-two days later, with increase of half-a-pound; and 858D, retaken in the sea, with increase of two and a-half pounds, after thirty-seven days.

While the majority of the marked clean fish, viz., the forty-six which were not recaptured, may or may not have passed to the upper reaches of the river and there remained, it seems reasonably certain that those retaken below the weir were mostly dropping back to the sea with a view to further feeding before finally committing themselves to the spawning redds. 861D presented, in the presence of sea-lice, undoubted evidence of return from the sea; 858D, retaken in the harbour with increased weight, is known, from the presence of sea-lice, to have been some time in the sea; while the increase noted in 870D may be presumed to have been achieved in the sea and not in the river.

Calderwood, in discussing the records of winter clean fish marked in the Spey (*op. cit.*, pp. 82–90) finds evidence of what he terms a "pausing habit" in the lower waters of the river, and makes certain suggestions as to the effect of temperature upon rapidity of ascent. In this I do not propose to follow him until it is possible to compare the results of successive years at Lismore, but I note that one record (2119, p. 90) of increased weight, which he regards as erroneous, would be quite explicable if, as in the Lismore cases noted above, the fish had visited the sea between the dates of marking and recapture. The

* With the exception of one reported as found dead, under circumstances which, I understand, are not wholly free from suspicion.

fact that, of the three fish which can certainly be proved to have reached the sea (433 D, 858 D, 861 D), two acquired an increase of weight before recapture, seems to suggest that the normal habit was not interrupted, since fish, inclined for a prolonged sojourn in fresh water, would not seem likely, if frightened seawards by the act of man, to resume the quest of marine food before again venturing up stream.

No Irish river presents the same facilities as the Blackwater for the study, by marking experiment, of the movements of winter clean fish, the importance of which, in our endeavour to acquire a knowledge of the life-history of salmon, require no explanation to anyone who is likely to give himself the trouble of reading this paper.

It is, therefore, I think, no less than a public misfortune that certain gentlemen interested in angling in the upper waters have raised so much objection to the continuance of the experiment, that the Department has decided to permit, during the ensuing season, no marking after the 25th December.

The only evidence which I have heard of alleged damage to clean fish by marking is the death of two clean fish, which were not observed to bear any traces of having been marked, at some point between Clondulane and Lismore. I notice in a report furnished by the clerk of the Lismore Conservators that an unusually large mortality of slats was caused by frost in the early spring of 1902. It seems not impossible that a few clean fish may also have been affected by this cause.

APPENDIX, No. XIV.

DRAWINGS AND DESCRIPTIONS OF APPARATUS USED IN SALMON AND TROUT CULTURE

AT THE

SANDFORT FISH FARM, OSNABRÜCK, GERMANY,

AND EXHIBITED BY THE DEPARTMENT AT

CORK INTERNATIONAL EXHIBITION, 1902.

GENERAL NOTES.

Among the apparatus for the artificial propagation of salmon and trout exhibited by the Department of Agriculture and Technical Instruction at the Cork Exhibition of 1902 were the appliances used by Herr Siegfried Jaffé, of Sandfort, Osnabrück. As these, from their simplicity of construction and working, seemed likely to be of use to many who are interested in fish culture in this country, the following drawings have been prepared in order to enable those who wish to use the apparatus to construct it for themselves.

It is of the greatest importance that all joints should be made thoroughly tight at the start. Continual drips cause dirt and discomfort in a hatchery, and it is not generally realised through what a small aperture several thousands of fry will escape in the course of a single night.

The perforated zinc of commerce is generally rough on one side; in every case the rough side should be turned away from the eggs or fry.

All the woodwork should be tarred or varnished. If tar is used, it should be laid on hot or thinned with turpentine, in several coats, in order to soak as far as possible into the wood. The proper varnish is "Asphaltum Varnish for hatchery purposes," which is manufactured by Sissons Bros., Ltd., of Hull.

All the wire netting and perforated zinc must be given three coats of this varnish. As the surface of the zinc will generally be greasy, it must be very thoroughly cleansed with soap and water before applying the varnish. Eggs must in no case be allowed to lie in contact with the bare metal.

It is advisable to give the apparatus a complete coat of tar or varnish annually, for the sake of disinfecting it as well as of preserving it. It should be allowed to soak for several days afterwards before putting in eggs or fry.

APPARATUS FOR USE IN THE HATCHERY.

Herr Jaffé recommends the use of two different patterns of trough for the earlier and later stages of batching.

The first of these, termed the "Incubating Trough," is intended to accommodate the eggs from fertilization until the eyed stage is reached.

The second, or "Hatching Trough," takes the eggs from the eyed stage until they batch, and may be used to retain the fry until the yolk is absorbed, if they are not transferred to "Floating Fry Nurseries."

In the case of a batchery system under which the eggs would be batched in "Floating Redds" in the streams where it is intended to enlarge them, the "Incubating Trough" would naturally be selected for use at the central or incubating station; but if it be intended to retain the eggs in the batchery until hatched, the use of both "incubating" and "batching" troughs, though desirable, is not essential, since the eggs can be dealt with from the earliest stages in the "hatching" trough, especially if a second set of coarse zinc trays be provided.

For the number of eggs accommodated, the "Incubating Trough" is considerably the cheaper, but is not considered to be entirely suitable for actual batching. Where, however, the supply of water is ample, this pattern of trough, with the necessary alterations in structure (and cost) appears likely to give good results.

SANDFORT INCUBATING TROUGH.

The objects for which this trough has been designed are described above. It is made in the form of a box $6\frac{1}{4}$ inches deep inside, with the lower end cut away to $2\frac{1}{4}$ inches from the bottom. At the upper end is a space for distributing the water, separated from the rest of the trough by a board sliding in grooves (so as to be removable for cleaning); the lower edge of the board is cut back at 1 inch from each side so that, when the sides rest on the bottom of the trough, in the centre there is a gap 13 inches by $\frac{3}{4}$ inch, through which the water enters the body of the trough.

The trough holds three trays, one of which is shown in isometric projection. Their capacity is about 5,500 eggs each. The sides of the tray are of wood and the bottom and ends are formed of a single sheet of perforated zinc. Should it be desired to get rid of the raw edges of the zinc at the ends a light half-round fillet of wood may be nailed across outside and the zinc bent down over it. This does not exist in Herr Jaffé's pattern, and is not shown in the drawing.

The transverse 1-inch by $\frac{1}{2}$-inch strips serve both to strengthen the tray and as handles for lifting it.

The perforated zinc for incubating is of the special pattern illustrated. the holes being $\frac{1}{4}$ inch by $\frac{3}{32}$ inch. In fastening on the zinc, care should be taken not to let its raw edges project beyond the sides of the tray, as they would destroy the inner surface of the trough.

The trays are supported on nails or pegs driven into the sides of the trough at such a height that the bottom of the tray is 1½ inches from the bottom of the trough and 1¼ inchee below the level of the outlet.

At the lower end of the trough is fitted a plug sufficiently large to allow it to be flushed out conveniently.

The outlet is in the form of a rectangular lip fastened to the sides and lower end of the trough. In connection with the outlet is fitted a sluice as follows:—The sides of the outlet are cut fully ½ inch shorter than the bottom, and behind it two vertical strips, ½-inch by ¼-inch, are fastened to the sides of the trough. Grooves are thus formed into which a piece of ½-inch board can be slid when required (see below).

Above the outlet the sides of the trough are braced together with a piece of 1½-inch by 1¼-inch section.

The covers of the trough are fitted as closely as possible without jamming, and have strips nailed across them to serve as handles, as shown in section.

The special pattern of perforated zinc allows the eggs to be cleaned during their early stages with a minimum amount of handling. This is done as follows:—The sluice at the foot of the trough is slid into place (it is shown in place in the drawing). When the water in the trough has risen sufficiently each tray is raised, and by moving it gently up and down in the water the silt is washed off the eggs. The sluice is then withdrawn and the water allowed to resume the level of the outlet.

The cost of the "Incubating Trough" should work out at from 14*s*. to 18*s*., according to circumstances (inclusive of tar and varnish).

To render the "Incubating Trough" suitable for hatching it should be made 1½ inches deeper and 6 inches longer, and of slightly heavier stuff. The level of the outlet should be raised to 3½ inches from the bottom, and the trays to 2¼ inches. A screen should be provided if required, as at the foot of the Hatching Trough, and two loose dams 2¾ inches high sbould be fitted between the trays. An extra set of No. 9 perforated zinc traye would be needed to take the eggs from the eyed stage onwards.

SANDFORT HATCHING TROUGH.

N.B.—In the Section and Plan, part of the trough has been omitted (to shorten it), but the full dimensions are given.

The Hatcbing Trough is similar in construction to the Incubating Trough, but narrower and deeper, and braced together witb two 1½-inch by 1¼-inch pieces, one near the middle and one at the lower end.

It carries two trays, 2 feet 9 inches by 8¾ inches, as illustrated, similar to the incubating trays, but made with ordinary No. 9 perforated zinc. Their capacity is about 5,000 eggs each.

In fastening on the perforated zinc care must be taken not to let the raw edges project at the sides of the trays.

The trays are supported on nails or pegs driven into the sides of the trough, with the bottom of the tray $2\frac{1}{2}$ inches from the bottom of the trough.

Between the trays is fitted a dam of $\frac{1}{2}$-inch board, 3 inches high, sliding in grooves so as to be removable.

Below the second tray is a screen of No. 9 perforated zinc sliding in grooves at an angle of 45 degrees, the frame of which is preferably made of oak, to avoid warping and jamming. This screen is not necessary unless the fry are turned out of the trays into the trough.

A plug is fitted as in the Incubating Trough, and the outlet is similar, but is $3\frac{1}{2}$ inches above the bottom of the trough.

The cost of the Hatching Trough as described above should work out at from 12*s*. to 16*s*. (inclusive of tar and varnish).

If the Hatching Trough is to be used for incubating, it is advisable to provide a second set of trays made of the perforated zinc used for incubating, and a sluice at the outlet to raise the water when washing the eggs.

The overflow from the Incubating and Hatching Troughs may fall directly into an open drain, or may be led down in a wooden shoot or in any convenient way, provision being also made for carrying off the water from the plug-hole.

Two trestles 2 feet 6 inches high will be found a convenient support for either trough.

APPARATUS FOR USE IN STREAMS.

FLOATING REDD.

Where it is found necessary to establish a central hatchery for the purpose of stocking a large catchment area, the transport of the fry is the principal difficulty to be contended with.

Again, it is sometimes desired to stock waters where it is not convenient to erect a hatchery, in which case the possibility of using eyed eggs instead of fry would admit of considerable saving in the expense.

The Floating Redd is designed to meet both the above wants. It consists essentially of a cage of perforated zinc, with a float round its upper edge to maintain it at the surface of the water, carrying inside three trays disposed in the same way as in the Incubating and Hatching Troughs.

The body of the Redd has a solid bottom of 1-inch boards with four 2-inches by $\frac{1}{2}$-inch transverse battens outside. Sides and ends have a tenoned framework of the scantlings shown on the drawings. No. 9 perforated zinc is fastened on the inside of the upper* end and six side panels, and inside the lower end is fitted a door (shown

* In the drawings, arrows show the direction of the current.

in section). The frame of the door is of 1¾-inch by 1-inch stuff, tenoned together, with two brass butt hinges above; a hook and screw eye are provided for holding it open during the enlargement of the fry, which should take place about the period of the absorption of the yolk; two buttons are attached to the frame of the Redd below for keeping the door shut; No. 9 perforated zinc is fastened on inside. The fitting of this door must be very carefully carried out, as the slightest chink may result in the escape of many fry before the proper season.

The "float" consists of a frame, tenoned together, fastened on top of the body of the Redd. At each end is a slot with rounded edges serving as a handle for lifting the Redd.

Inside this frame there are two hinged covers framed like the other parts, with two panels of ½-inch mesh wire netting in each. The covers are provided with handles, as shown in plan and section, and a transverse ledge is nailed at each end of the Redd to support them when shut. The ledge at the upper end is 1 inch by ¾ inch, and that at the lower end is reduced to ½ inch by ½ inch to facilitate the opening of the door.

The trays are of the same pattern as the incubating trays (see page 198, and drawing), but of slightly different dimensions, viz.:— 1 foot 8¼ inches long by 1 foot 3¼ inches wide, outside, by 3¼ inches deep. They are supported on nails or pegs driven into the stiles of the side panels of the Redd, at 2½ inches from the bottom (see section, Fig. 4). For salmon eggs it is advisable to have the trays at about 9 inches from the bottom.

Should it be desired to effect an economy by using the trays of the Incubating Troughs in the Floating Redds, the simplest way would be to make the incubating trays shorter and to drive the pegs for supporting them in the Redd into ½-inch battens fastened vertically inside. It is regarded as inadvisable to decrease the width of the body of the Redd.

The cost of the Floating Redd may be estimated at somewhere about £1 10*s*.

It is intended to be moored in a stream suitable for fry, and in a good current.

The simplest attachment for the mooring chains is a strap of galvanised fencing wire placed round the Redd and stapled to its sides.

If leaves and other *debris* are plentiful, a screen should be provided at a sufficient distance above the Redd or series of Redds.

If necessary, the trays may be placed two deep in the Redd, provided there is an adequate supply of good water.

FLOATING FRY NURSERY.

In the system of fish culture pursued by Herr Jaffé the alevins are never fed in the hatching troughs; but as soon as the yolk sac has hardened, *i.e.* about ten days after hatching, they are removed to Floating Nurseries, where they are fed and kept till about four months old.

The Nursery is a simple cage. The bottom is of 1¼-inch boards; the sides and ends have panels of No. 9 perforated zinc. Above these panels is a horizontal frame 4¾ inches wide at the sides and 5 inches at the ends (in the specimen from which the dimensions were taken), round the inner edge of which is a coaming 4 inches high, on which rests the hinged cover. Behind, at the corners, are blocks to keep the cover from falling back when opened.

The cover has three panels, of which the centre one is boarded over, and the others covered with ½-inch mesh wire netting; it has strong iron hinges, and hasps which serve as handles for raising it and enable it to be padlocked if necessary.

Four handles of ½-inch diameter round iron (or 7/0 gauge wire) firmly fastened with screws in the positions shown, serve for the attachment of the chains by which the Nursery is moored, and for carrying it when necessary.

It should float with about three-quarters of its depth immersed. Its capacity will be anything from 10,000 to 30,000 fry, according to the quantity and quality of the water passing through it. In streams where the flow of water is poor, an improvement may be effected by concentrating the force of the water against the end of the Nursery. The same may be done in the case of the Floating Redd.

The cost of the Floating Fry Nursery may be taken to be somewhere about £1 5*s*.

FITTINGS FOR PONDS.

POND INLET.

This piece of apparatus consists of a horizontal shoot, in the centre of which is placed a screen to intercept the grosser constituents of water-borne *débris*, while at the lower end is a dam for regulating the supply of water to the pond. The direction of the stream is shown by arrows on the plan. At the upper end of the screen a solid piece of wood 4 inches high runs across the shoot, and is firmly fixed to the bottom and sides. To this the screen is hinged with strong brass hinges.

It is advantageous in some cases to make the screen instantaneously removable. This may be accomplished by utilising brass bolts for hinges.

The screen is composed of the following parts:—

(1.) A frame 3 feet 4 inches by 1 foot 7 inches outside, tenoned together.

(2.) A sheet of No. 9 perforated zinc, fixed on top of the frame by 1½-inch by ¼-inch battens nailed over it.

(3.) At the lower end of the screen a vertical piece of 1½-inch stuff is firmly fastened to the frame, running right across, and having its upper edge level with the edge of the shoot. To the down-stream side of the upper edge is nailed a strip 1 inch by 1 inch, which serves as a handle for raising the screen.

The screen must be made to fit the shoot as neatly as possible, so long as it is free to be raised and lowered (as indicated by dotted lines in the section A.-B.). It rests on two strips 3 inches high nailed to the sides of the shoot underneath.

The screen needs to be raised in order to be thoroughly cleaned on both sides from time to time. This is best done with the aid of a stiff brush.

The horizontal screen, as compared with a vertical one, offers a much larger space for the passage of the water. Its liability to clog is thereby decreased and a more regular supply of water ensured.

One of these inlets should be fitted where the water supply enters each pond, whether from a conduit or another pond. The inlet should be sunk in the ground to such a depth that its bottom is slightly below the surface level of the lower pond.

A certain amount of adjustment is possible by varying the height of the dam at the lower end of the inlet.

Its cost may be taken to be somewhere about £1.

POND OUTLET.

Each pond should, if possible, be fitted with an outlet to enable it to be emptied independently of any other with which it may be connected.

The outlet, sometimes called a "pepper-box sluice," consists of a vertical box divided into two compartments by a dam. The water passes through the front of the box into the front compartment, over the dam into the back compartment, and out through an aperture at the back.

The front of the box is composed of the following parts, all of which slide in vertical grooves (see drawings):—

(1.) At the bottom, two 1-inch boards, each 9 inches high.

(2.) Above these a screen 1 foot 11 inches high, the frame of $1\frac{3}{4}$-inch by 1-inch stuff, tenoned together; perforated zinc tacked on in front.

(3.) Next above, a similar screen 1 foot 7 inches high, the frame 1 inch by 1 inch, tenoned together; perforated zinc in front.

(4.) At the top a 1-inch board 5 inches high, level with the top of the box.

Close behind these, the sides of the box are held together by two transverse $1\frac{1}{2}$-inch by 2-inch bars of oak, one at the top the other about half-way down.

The dam consists of a series of 1-inch boards sliding in vertical grooves. Each board is 9 inches high, except the top one, by which the height of the water is regulated.

A notch should be cut half-way through the lower edge of each board to provide a grip for hauling it up when the pond is to be emptied.

The opening through which the water escapes is in the back of the box, and should be cut so as to facilitate making a perfectly

tight joint with the drain. The dimensions in the drawing are taken from Herr Jaffé's model.

The parts sliding in grooves should he fitted as neatly as possible to the grooves and to one another, in order to avoid waste of water, due allowance being made to prevent them from jamming when wet. Strips of tarred felt fastened to the edges of the vertical boards will assist in making the dam water-tight.

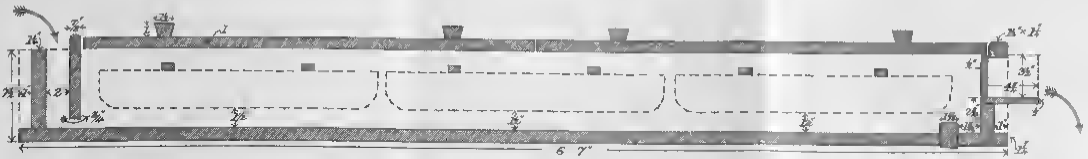
The perforated zinc to he used in the screens will be No. 9 in Fry Ponds; larger sizes may he used in ponds for large fish.

By the use of this form of outlet the fish are effectually prevented from escaping into the drains, and the pond may be gradually lowered to any desired level for the purpose of inspecting or capturing the fish. To make all safe, the top of the outlet should be provided with a cover, which may be fitted with hinges and a padlock.

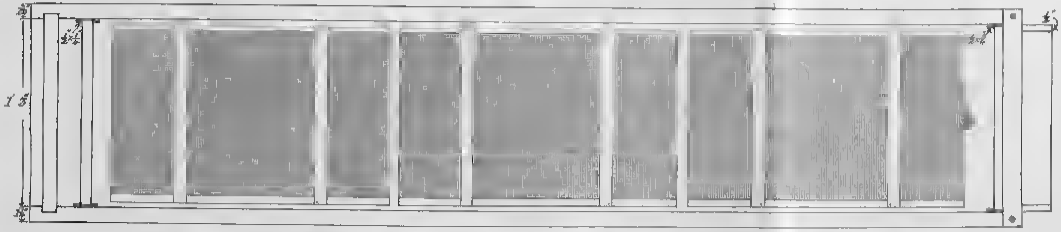
The outlet should he let into the side or end of the pond in such a way as to he easily accessihle, and should be sunk to such a depth that the drain is level with the bottom of the pond.

It is of the highest importance to make a tight joint with the drain, as the slightest leak may quickly destroy the embankment.

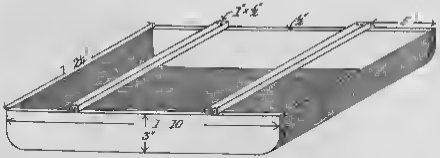
The Pond outlet should cost somewhere about 15*s*.



SECTION



PLAN *(Covers removed.)*



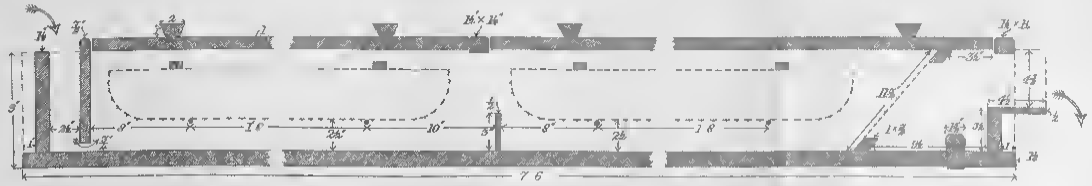
TRAY

PERFORATED ZINC FOR TRAYS

INCUBATING TROUGH

C. GREEN del

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND
FISHERIES BRANCH



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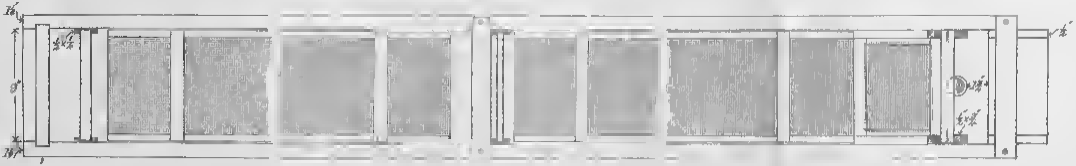
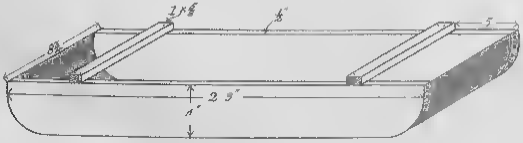
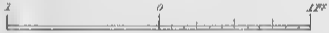


PLAN *(Covers removed)*



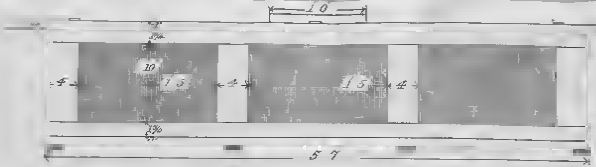
TRAY



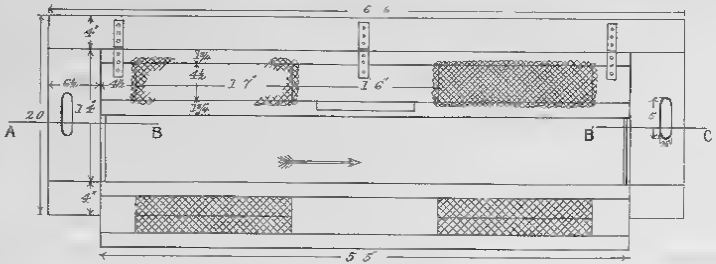
HATCHING TROUGH.

C GREEN del

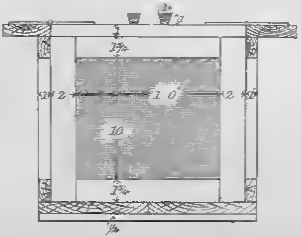
DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND
FISHERIES BRANCH



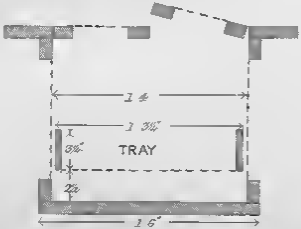
1 SIDE ELEVATION



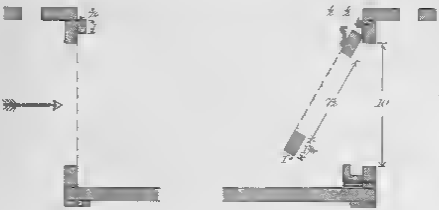
2 PLAN *(One Cover turned back)*



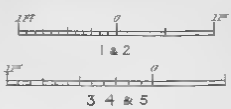
3 END ELEVATION *(Upper)*



4 TRANSVERSE SECTION



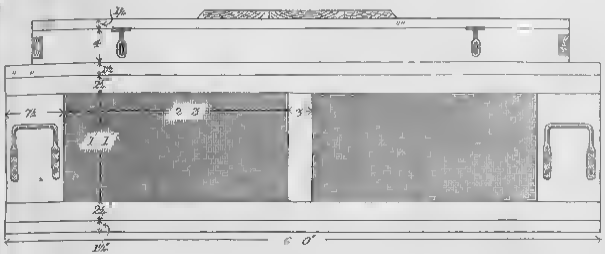
5 SECTION A-B B'-C



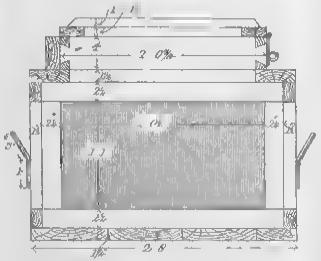
FLOATING REDD

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND
FISHERIES BRANCH

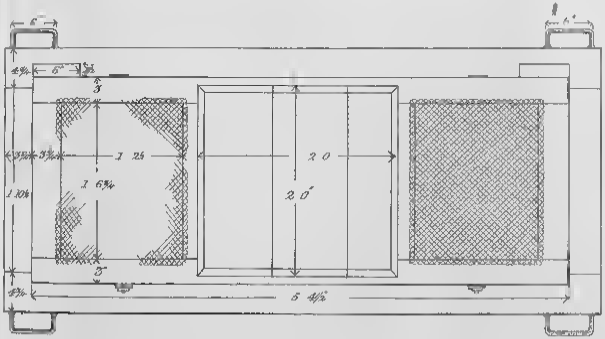
C GREEN del



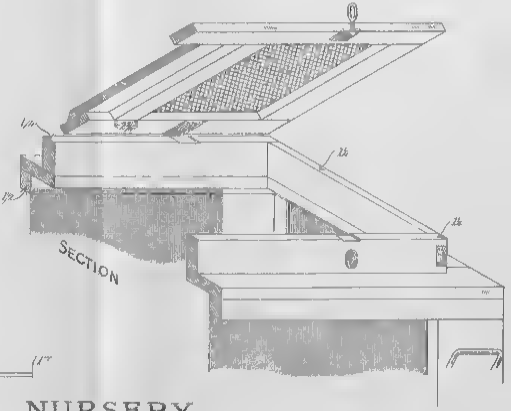
SIDE ELEVATION



END ELEVATION



PLAN

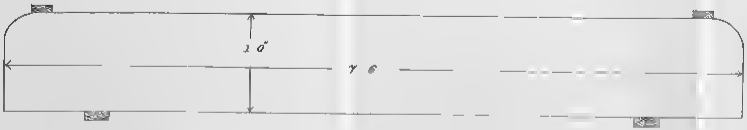


SECTION

FLOATING FRY NURSERY

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND
FISHERIES BRANCH

L. GREEN del



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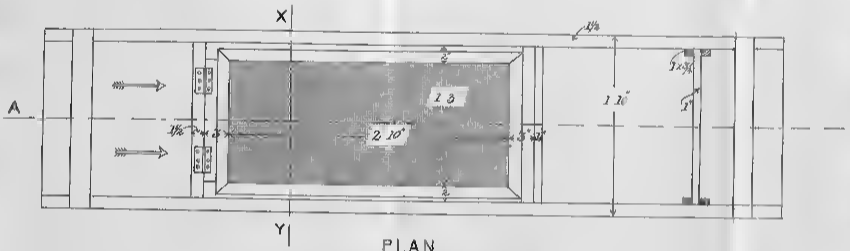

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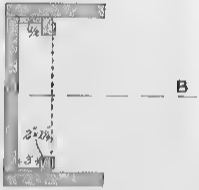

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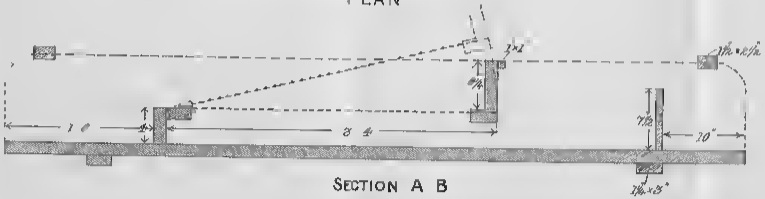

SECTION A B

POND INLET.

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND
FISHERIES BRANCH

POND OUTLET.

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND
FISHERIES BRANCH.

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Appendix, No. XV.

SUBSTANCE OF REPORTS RECEIVED FROM CLERKS OF CONSERVATORS RELATIVE TO SALMON FISHERIES.

APPENDIX

SUBSTANCE of REPORTS received from CLERKS of

DISTRICT.	What is the general state of the Salmon Fisheries in this District? Are they as a rule improving or declining? (1)	Has the take of Salmon and Grilse by nets and weirs throughout the District been more, or less, productive in the present year than in the past one? (2)	Has the take of Sea Trout by nets been more, or less, productive this year than in the past one? (3)
Dublin,	Fair; improved a little at Ringsend.	Slightly more productive,	About the same,
Wexford,	An improvement this year,	More salmon, less grilse,	More,
Waterford,	Although not satisfactory show improvement on previous year.	More productive,	Little or no take of sea trout by nets.
Lismore,	Not satisfactory; declining,	More salmon, less grilse,	About the same,
Cork,	Fair; no material change,	About the same,	—
Do., Bandon,	A slight improvement,	Slightly more productive,	No netting for sea trout,
Skibbereen,	Very poor; not improving,	Less,	Less,
Bantry,	Bad; declining,	Much the same,	Few taken this year,
Kenmare,	Declining,	Less productive,	No netting for sea front,
Waterville and Killarney.	Indifferent; spring fishing slightly improved, summer declining.	About the same,	Less,
Limerick.	Unchanged,	Much more by stake weirs, less by nets, except snap nets in fresh waters, which did very well.	Sea trout fishing in Shannon is of no mercantile value.
Galway,	Much below the average, but improving.	Slight increase on last year, but still below average; good take on Spiddle River.	Less,
Connemara,	Bad; declining,	—	—
Ballinakill,	Much better than last year,	More,	More,
Bangor	Lough Furnace slightly improving, all rivers declining.	Less,	Less,
Ballina,	Declining,	Not more,	Less,
Sligo,	Bad generally, but slightly improving.	Salmon more, grilse a little less.	Much less,
Ballyshannon,	Slightly better,	More productive,	Very little netting for sea trout.
Letterkenny,	Fairly good; no apparent change.	No change observable,	Slight improvement,
Londonderry,	Fairly satisfactory,	More productive,	More productive,
Coleraine,	Rather worse than last season.	Salmon fairly plentiful, better than last year; grilse extremely scarce.	Much the same as last year.
Ballycastle,	A very poor season,	Less,	Very rarely taken,
Dundalk,	Good; improving,	More,	Average,
Drogheda,	Improving,	Somewhat better than last year.	Much better than last year.

No. XV.

Conservators relative to Salmon Fisheries.

Has any peculiarity been observed in the date at which fish have appeared in the rivers this season? (4)	What is your report as to Angling in the District? (5)	District.
Earlier than usual. There was no autumn run worth speaking of.	Not good: getting worse every year,	Dublin.
No,	Better than last year,	Wexford.
No; spawning fish appeared later than usual owing to absence of freshes.	Fairly good on Suir and Nore; occasionally good on Barrow.	Waterford.
No,	Very good up to end of May,	Lismore.
No,	Fairly good,	Cork.
No,	Slightly better,	Do. Bandon.
No,	Poor; white trout fishing good,	Skibbereen.
No,	Bad,	Bantry.
None taken before June,	Bad: very little angling,	Kenmare
No,	Poor on Killarney Lakes; worst season for many years on Waterville Lake; on the rivers indifferent.	Waterville, and Killarney.
Same as previous year for spring salmon; grilse ten days later than previous year.	Improved in the spring, but grilse fishing bad in June and July owing to dry weather.	Limerick.
No,	At Galway spring fishing very good, summer fishing fair, other parts of district poor for salmon but very good for trout.	Galway.
No,	Lower Costello and Gowla good; other fisheries bad.	Connemara.
No,	Very poor; fish, although plentiful, did not rise well.	Ballinakill.
No,	Not a good season, too dry,	Bangor
No,	Not good, weather unfavourable,	Ballina.
Salmon at usual time; grilse about fourteen days later.	A decided improvement,	Sligo.
No,	Not very good,	Ballyshannon.
No,	Not as good as in former years owing to dry weather.	Letterkenny.
No,	Fair,	Londonderry.
No,	Good during first half of season, but extremely bad during latter half owing to dry weather and flax pollution.	Coleraine.
No,	Early spring poor, later on in April and May good.	Ballycastle.
Rather later than in previous year,	Fair,	Dundalk.
No,	Better than previous year,	Drogheda

APPENDIX,

SUBSTANCE of REPORTS received from CLERKS of

DISTRICT.	What was the highest wholesale price, per lb., given for Salmon this season? (6)	What was the lowest wholesale price, per lb.? (7)	Between what dates did the principal migration of Smolts take place? Was it larger or smaller than usual? (8)	Has there been observed more than one migration of Smolts to the sea during the season? If so state dates when these migrations took place. (9)
	s. d.	*s. d.*		
Dublin, . . .	3 3	1 2	April and May, . .	Yes; July and October.
Wexford, . .	3 0	0 10	March, April, and May, .	Yes; on 29th and 30th June.
Waterford, . .	2 6	1 2	End of March to early in May—larger.	Yes; in August and September.
Lismore, . .	2 2	0 11	March and April—larger, .	No, . . .
Cork, . . .	1 8	0 10	As usual, . . .	No, . . .
Do., Bandon, .	2 2	0 8	During April—average, .	No, . . .
Skibbereen, . .	1 3	0 10	April—larger, . . .	No, . . .
Bantry, . .	0 10	0 9½	April and May—smaller, .	No, . . .
Kenmare, . .	1 2	0 8	About March, . .	None observed, .
Waterville and Killarney.	2 6	0 11	March to May, inclusive—larger.	No, . . .
Limerick, . .	2 9	0 11½	April and May—smaller, .	Yes; September and October.
Galway, . .	2 10	0 11	April and May—larger, .	Yes; September and October.
Connemara, .	None sold. .	None sold, .	April and May—average, .	No, . . .
Ballinakill, . .	1 0	0 7	Cannot say, . . .	Cannot say, . .
Bangor, . .	2 7	0 10	25th March to 12th May—average.	Yes; two in Carrowmore River first week in April and last week in May.
Ballina, . . .	2 6	0 10	April and May—larger, .	Yes; in April and May.
Sligo, . .	5 0	0 10	April and May—larger, .	Yes; on 10th, 19th, 20th and 26th May.
Ballyshannon, .	2 6	1 0	Middle of April to end of May—about the same.	Yes; in Bundrowes River in October, .
Letterkenny, .	2 6	0 8	Could not ascertain owing to high floods.	No, . . .
Londonderry, .	2 9	0 10	April and May, inclusive, .	Yes; several between middle of March and middle of June.
Coleraine, . .	2 6	1 0	Between March and July—more plentiful.	Yes; at every flood from March to July.
Ballycastle, . .	2 1	1 0	Between middle of April and 1st June.	No, . . .
Dundalk, . .	2 6	1 0	End of April to middle of May—larger.	No, . . .
Drogheda, . .	2 0	0 7	Not known, . . .	Yes; chiefly in April,

No. XV.—*continued.*

CONSERVATORS relative to SALMON FISHERIES.

In your opinion was the weather Favourable or Unfavourable to		At what period of the year is Grilse first taken?	During what months is the greatest quantity observed or taken?	DISTRICT.
Netting. (10)	Angling. (11)	(12)	(13)	
Favourable,	Unfavourable,	June and July,	July,	Dublin.
Fairly good,	Favourable to end of May.	—	June and July,	Wexford.
Fairly favourable,	Unfavourable during latter half of season owing to low water.	May,	July and August,	Waterford.
Fair,	Favourable until June.	May	June and July,	Lismore.
Unfavourable,	Unfavourable.	May,	June,	Cork.
Unfavourable in early season.	Favourable, except from June to Aug.	June,	Early in July,	Do., Bandon
Favourable,	Favonrable.	End of June,	Middle of July,	Skibbereen.
Unfavourable,	Unfavourable until September.	July,	July,	Bantry.
Unfavourable,	Unfavourable,	June,	July,	Kenmare.
Unfavourable in summer.	Unfavourable in summer, water low and bright from June to August.	End of May,	June,	Waterville & Killarney.
Unfavourable for drift and draft nets, favourable for snap nets.	—	May,	June,	Limerick.
Generally favourable,	Generally favourable,	May,	June,	Galway.
Favourable,	Unfavourable,	June,	June and July,	Connemara.
Generally favourable,	Unfavourable,	June,	July,	Ballinakill.
Favourable,	Unfavourable,	May,	July,	Bangor.
Unfavourable,	Unfavourable,	May,	June and July,	Ballina.
Fair,	Unfavourable, owing to low water.	May,	June and July,	Sligo.
Favourable,	Favourable,	Middle of June,	July,	Ballyshannon.
Favourable,	Unfavourable, except in May and Sept.	June and July,	Early in August,	Letterkenny.
Favourable for sea, unfavourable for fresh water.	Unfavourable,	End of May.	July,	Londonderry.
Most unfavourable in fresh waters, too mild for drift nets in tidal waters.	Too dry,	End of May,	24th June to 20th July.	Coleraine.
No,	Bad in spring, good in April and May.	Beginning of May,	—	Ballycastle.
Favourable,	Favourable.	July,	End of July and first week in August.	Dundalk.
Favonrable,	Favourable,	June,	July,	Drogheda.

APPENDIX,

SUBSTANCE of REPORTS received from CLERKS of

DISTRICT.	During what months are many Salmon taken with the Grilse? (14)	Are these Salmon on an average heavier or lighter than at other periods? (15)	In what months are the greatest quantities of Salmon (not Grilse) captured? (16)	Can it be ascertained what proportion the capture of Grilse bears to the capture of Salmon? (17)
Dublin,	July,	Lighter,	In February, March, and April at Islandbridge; May, June, and July at Ringsend; August and September from Dalkey to Wicklow.	4 to 1,
Wexford,	June,	Heavier,	April and May,	1 to 2,
Waterford,	June to August,	Lighter,	April to June,	Cannot ascertain,
Lismore,	May, June, and July.	Average weight,	February to May,	Cannot ascertain.
Cork,	May and June,	Average weight,	May, June, and July	No,
Do. Bandon,	July,	Heavier,	May and June,	About 2 to 3,
Skibbereen,	July and August,	Heavier,	First week in August,	About 3 to 1,
Bantry,	June and July,	Heavier,	July,	20 to 1,
Kenmare,	June and July,	—	July,	20 to 1,
Waterville and Killarney.	June,	Heavier,	January to April, inclusive.	3 to 1,
Limerick,	May,	Lighter,	April and May,	4 or 5 to 1,
Galway,	July,	Lighter,	April,	4 to 1,
Connemara,	July and August,	Heavier on Ballinahinch, average elsewhere.	Costello, Screebe and Inver, August and September; other fisheries, July and October.	Ballinahinch and Screebe about equal: other fisheries 1 to 3.
Ballinakill,	June,	Same weight,	May, and first week in June.	12 to 1,
Bangor,	May,	Heavier,	April and May,	5 to 1,
Ballina,	June and July,	Average,	May, June, and July,	No,
Sligo,	April to July,	Heavier,	January, February, and March.	1 to 2,
Ballyshannon,	June and July,	Lighter,	May and June,	3 to 4,
Letterkenny,	June,	Lighter,	June and July,	5 to 1,
Londonderry,	June to August,	—	July and August,	No; but greater number are Grilse.
Coleraine,	June and August,	Heavier,	End of April, May, and beginning of June.	—
Ballycastle,	—	—	Up to 1st May, and again from 20th July.	—
Dundalk,	July,	Average,	February and September.	2 to 1,
Drogheda,	July,	Lighter,	April,	Not known.

No. XV.—*continued.*

CONSERVATORS relative to SALMON FISHERIES.

Is there any increase in the average size of the Spring Salmon or Grilse? Give average weight of Salmon and Grilse in the season of this year as far as practicable.		Has any sign of disease been observed amongst the Salmon during the year? If so, describe it, and state if it was prevalent to any extent, and where?	DISTRICT.
Salmon. (18)	Grilse. (19)	(20)	
No; about 14 lbs., . .	No; about 4 lbs., . .	No, ...	Dublin.
About 12 lbs.. . .	About 5 lbs., . . .	Four salmon with fungus on them seen in Slaney near Newtownbarry.	Wexford.
No, with exception of early spring fish; from 12 lbs. to 14 lbs.	From 4 lbs. to 5 lbs., .	No.	Waterford.
No; 10 lbs. to 29 lbs., .	No; 3 lbs. to 6 lbs., .	No, ...	Lismore.
Yes; about 8 lbs., . .	Yes; about 3 lbs., . .	No, ...	Cork.
Yes; about 11 lbs, . .	Yes; 5 lbs. to 6 lbs., .	No, ...	Do., Bandon.
No; 8 lbs. to 12 lbs., .	No; 7 lbs. to 9 lbs., . .	No, ...	Skibbereen.
No; about 12 lbs., . .	No; about 5 lbs., . .	No, ...	Bantry.
No; 11 lbs., . .	No; 6 lbs., . . .	No, ...	Kenmare.
No; about 10 lbs, . .	No; about 5 lbs, . .	No, ...	Waterville and Killarney.
16 to 19 lbs., . . .	5 lbs., ...	No, . . .	Limerick.
Yes; about 14½ lbs., .	About 6 lbs., . . .	A few fish were taken with patches of fungi on them.	Galway.
No; 10 lbs. . .	No; 7 lbs. . . .	No.	Connemara.
Yes; about 11¾ lbs., .	Yes; about 6½ lbs., . .	No, ...	Ballinakill.
No; about 9½ lbs, . .	No; about 5¾ lbs., . .	No, ...	Bangor.
No; about 10½ lbs., . .	No; about 6½ lbs., . .	No, ...	Ballina.
Yes; about 9½ lbs., . .	No; about 6½ lbs., . .	No.	Sligo.
Yes; about 18 lbs., . .	No; about 5 lbs., . .	No.	Ballyshannon.
No; from 12 lbs. to 14 lbs., .	No; from 6 lbs. to 8 lbs., .	No, ...	Letterkenny.
No; about 10 lbs., . .	No; about 6½ lbs., . .	No, ...	Londonderry.
Yes; about 13 lbs., . .	No; about 6 lbs., . .	No, ...	Coleraine.
Yes; from 10 lbs. to 25 lbs.,	Yes; from 5 lbs. to 7 lbs., .	No, ...	Ballycastle.
Yes; 13 lbs., . . .	Yes; 6 lbs., . . .	No, ...	Dundalk.
Average 12 lbs., . .	Average 6 lbs., . .	No, ...	Drogheda.

APPENDIX,

SUBSTANCE of REPORTS received from CLERKS of

DISTRICT.	During the descent of Fry to the Sea is Angling for Trout prohibited by any of the Proprietors of Fisheries. Does much destruction of Fry take place? (21)	Can you give any information about the run of Salmon and Grilse in each month of the Close Season? (22)
Dublin,	Yes, by some proprietors. Very little destruction of fry.	Good runs in March, April, and May; no autumn run.
Wexford,	Angling not prohibited. Not much destruction of fry; notices against killing them have been posted.	Salmon go up the rivers to spawn in October, November, and December; grilse earlier.
Waterford,	No. Yes, by young anglers,	Depends on the condition of the water. In September and early part of October some spawning fish may run, and if favourable floods occur during latter part of October and in November the principal run takes place. This may be delayed owing to absence of floods until December.
Lismore,	Yes; at Lismore only. Much destruction of fry takes place.	Grilse run in October; salmon and grilse in November and December.
Cork,	No. Scarcely any destruction of fry takes place.	No,
Do, Bandon,	No. No destruction takes place,	No,
Skibbereen,	No; very little trout angling,	Fish ran for three weeks after close season.
Bantry,	No,	No,
Kenmare,	No; no angling till 1st April,	Cannot ascertain,
Waterville and Killarney.	No. Not much destruction caused,	No, but the run of salmon as compared with grilse appeared small.
Limerick,	No. Some destruction takes place,	No,
Galway,	Yes; in the Galway several fishery,	Practically no run until early in January.
Connemara,	Yes,	No,
Ballinakill,	No. No destruction to fry as far as can be ascertained.	No,
Bangor,	Yes; in all rivers of any importance. Not much destruction of fry.	No,
Ballina,	Yes; during April and May by by-law,	No,
Sligo,	No. A good deal of destruction takes place in consequence.	A good number of salmon run up in November and December.
Ballyshannon,	Yes; trout fishing prohibited,	—
Letterkenny,	No; but it is not carried on to any extent during this period.	No reliable information,
Londonderry,	No. Many fry are killed by trout anglers,	Greatest runs in October and November.
Coleraine,	No. Some destruction of fry takes place but not to any serious extent.	At end of August a small run of salmon and grilse: other runs in September and October.
Ballycastle,	Yes, in Bush River. Destruction takes place in other rivers.	Constantly run during floods,
Dundalk,	Yes. Not much destruction of fry,	The run of salmon and grilse larger than usual.
Drogheda,	No. Some fry are destroyed,	September, October, and November are the chief months in which they run.

No. XV.—*continued.*

CONSERVATORS relative to SALMON FISHERIES.

Have you any reason to suppose that many Spent Fish have been destroyed hitherto in the months of February and March, and Full Fish in the month of October by Anglers? (23)	Have there been cases of poisoning the rivers in the District? If so, give particulars of the different cases, and if by Lime, Spurge, or Flax Water? (24)	Have offences against the Fishery Laws increased or diminished? What proportion (approximately) may be attributed to those who took out licences and those who did not? (25)	DISTRICT.
No, ...	Complaints were made that deleterious matter was allowed to flow into Liffey, Camac, and Dodder from railway works, paper mills, and laundry, respectively.	Diminished, . .	Dublin.
No, ...	No, ...	Decreased, 1 to 15, .	Wexford.
Yes; unavoidably, . .	No, ...	Diminished, . .	Waterford.
Not so much as in previous years.	One, by emptying spraying chemicals into a tributary.	Diminished, 1 to 2, .	Lismore.
Possibly a few, but to no great extent.	No, ...	Diminished; those committed chiefly by licence holders.	Cork.
Yes, ...	No, ...	Diminished, . .	Do., Bandon.
No, ...	No, but explosives (Tonite) have been used.	Diminished, . .	Skibbereen.
Not to my knowledge, .	Two by spurge, very little damage done.	No offenders have been detected.	Bantry.
Have hot heard of any, .	Ronghty Rivor twice poisoned, once with spurge; Killagh River, once with lime.	Diminished; all by unlicensed persons.	Kenmare.
Not many spent fish, but a good many full fish killed in October.	One case of poisoning by lime in Brown Flesk.	Diminished as compared with former years, but not more than 1 per cent. fish without a licence.	Waterville and Killarney.
Yes, in February and March; fish taken in October may be regarded as full fish.	Yes; one by lime in Listowel District.	Decreased; greater number by unlicensed persons.	Limerick.
No, ...	A certain amount of pollution discharged from a woollen factory in Galway.	No increase; no offences by licence holders.	Galway.
No.	No, ...	Diminished; non-licence holders are always the offenders.	Connemara.
No; a few full fish killed by anglers in October,	No, ...	Decreased, . . .	Ballinakill.
No, ...	No, ...	Very much decreased, .	Bangor.
No, ...	None save by flax water, .	No increase, . .	Ballina.
Yes; spent fish are destroyed by anglers in October, but very few full fish.	Yes, by the wash from creameries and by dynamite.	About the same as in previous year.	Sligo.
A few spent fish were taken in Lough Erne by cross lines.	No.	Diminished, . .	Ballyshannon.
No spent fish destroyed, but some full fish destroyed in October.	None save by flax water, .	Diminished, 1 : 99, .	Letterkenny.
Some spent fish destroyed in April, and some full fish in beginning of October.	Numerous cases by flax water.	About the same, . .	Londonderry.
Little damage as to spent fish, but full fish are taken in Maine and Blackwater in October.	Three cases of poisoning by lime and 81 by flax water.	About the same; very few attributable to licence holders.	Coleraine.
No, as to spent fish; yes, to a certain extent, as to full fish	No, an odd flax water case only.	Diminished; as a rule licence holders do not offend.	Ballycastle.
No, ...	No, ...	Diminished; none by licensed anglers.	Dundalk.
Some spent fish are killed in February and March.	No, ...	Diminished, . .	Drogheda.

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